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**JOURNAL OF
SCIENTIFIC AND INDUSTRIAL RESEARCH**

**VOL. IV
(1945-1946)**

**COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH
DELHI**

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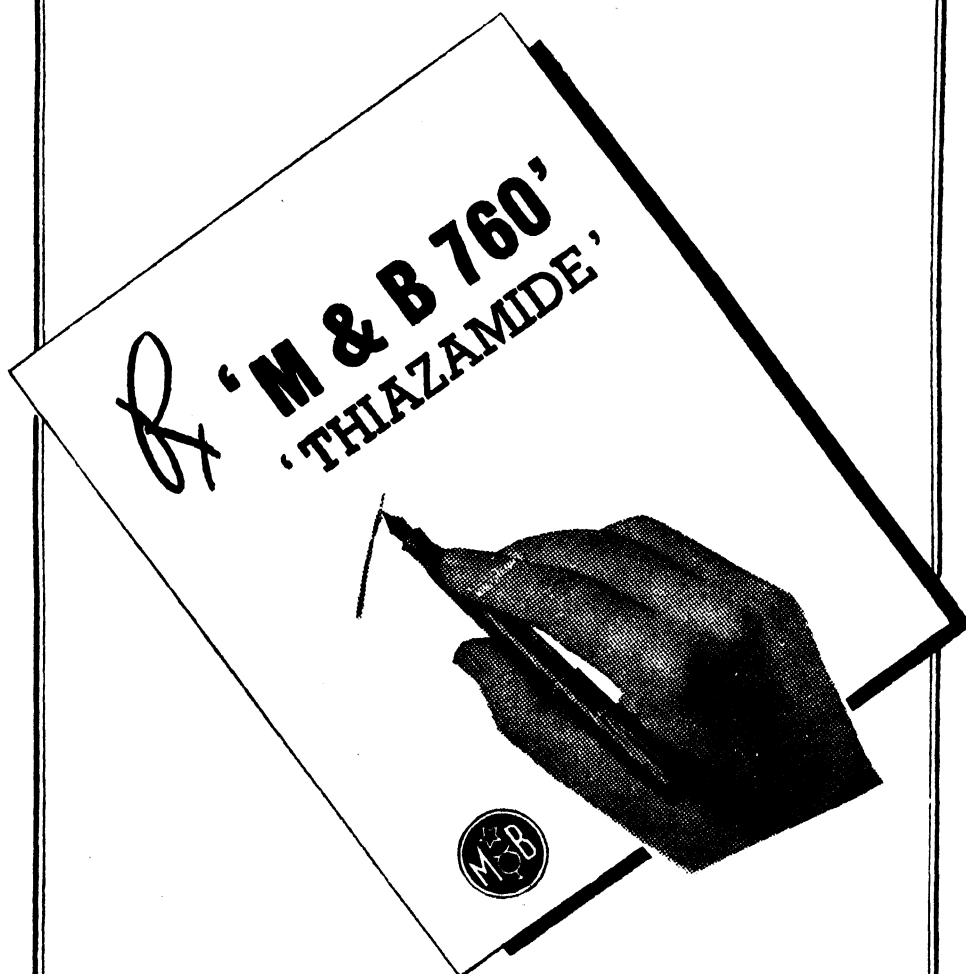
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THE ACADEMY OF SCIENCES, U.S.S.R.

THE Academy of Sciences, U.S.S.R., celebrated the jubilee of its foundation on the 15th and 25th of last month in Moscow and Leningrad. More than 1,200 scientists from all parts of the world took part in the festive celebrations and paid homage to Soviet science and to the distinguished Soviet scientists who by their brilliant contributions have enriched human knowledge and culture. Indian science was represented by the eminent astrophysicist, Professor Meghnad Saha, and his high praise for Soviet science is shared with equal enthusiasm by all the scientists of this country.

The jubilee celebration was of more than usual significance and interest. It followed the great victory in Europe against an aggressive enemy who had invoked to his aid all the lethal weapons and techniques which scientific discovery and invention had placed at his disposal. Soviet scientists have fulfilled with conspicuous success the grim responsibility of mobilizing the resources and of placing at the disposal of the Red Army, techniques and weapons which were markedly superior to those of the enemy. They have returned to their peace-time duty of reconstruction and rehabilitation with confidence greatly strengthened by the victory which they have so deservedly secured. They have shown to the world at large that there is no obstacle which they cannot counter, and no problem which they cannot solve. The celebration marks also the anniversary of the birth of a great organization which has galvanized life in Sovietland and which through planned application of science, has

developed the productive forces and raised the material standards of the working people.

To understand and assess the great work of the Academy of Sciences, U. S. S. R., it is necessary to turn back to the conditions in Russia before the October Revolution of 1917. Under the Tsarist Government, Russian economy was predominantly agricultural, with 80 per cent. of her population engaged in rural occupations. The people were poor and uneducated. The material resources of the country were unexplored and unutilized. Reconstruction on an ambitious scale was taken up only after the Revolution. In 1919-20, at the initiative of Lenin and Stalin, and with the collaboration of some two hundred scientists and engineers representing diverse departments of knowledge, the Soviet Government launched the celebrated plan for the electrification of Russia. The Imperial Academy of Sciences, which was founded by Peter the Great in 1725, and which had remained quiescent for nearly two centuries, was charged with the task of mobilizing the scientific resources of the country. The Academy was required to direct "the whole body of scientific knowledge towards the reconstruction of national economy." A number of members of the Communist party, distinguished for their work in various branches of technological science, were admitted to the Academy in 1929. The Academy itself was made directly responsible to the Government of the U. S. S. R. in 1934, and its headquarters transferred to Moscow with a view to bring it into closer contact with the State Planning

Commission. Marshal Stalin was elected a member of the Academy in 1939, and the event was regarded as a symbol of the transformation of the Academy into the "General Staff of Soviet science."

Under the guidance of the Academy, science has made great strides in the U. S. S. R. In the year 1938, there were no less than 902 research institutes (excluding factory and farm laboratories and observatories in the Arctic) with a total staff of 29,246 scientists. The grand total of scientific workers in January 1938, was 80,000 and this figure has been greatly exceeded during recent years. Budgetary appropriation for science in the same year was 1,016 million roubles. Science and Socialist economy are closely interwoven. None of the great discoveries of science is allowed to wither away by disuse. Research and development go hand in hand, and every discovery and invention is fully utilized. Research institutions in the U. S. S. R. are divided into two categories—Governing Institutes, comprising those functioning directly under the Academy and devoted to basic and key researches, and Departmental Institutes, comprising those attached to various branches of industry and agriculture under the People's Commissars. The Governing Institutes carry out fundamental researches which help in the development of the productive resources of the country. The results obtained are elaborated by technological researches in Departmental Institutes, which have the responsibility of not only improving technical processes but also of developing new ones. These Institutes work under the supervision of, and in constant consultation with, the Governing Institutes concerned. Where separate Departmental Institutes do not exist, the Governing Institutes themselves undertake developmental work. The Departmental Institutes exercise control over factory laboratories which are especially concerned with the techniques of production and the solution of routine problems incidental to production operations. This distribution of responsibility renders possible the full utilization of scientific research.

On the question of planning of science in the U. S. S. R., a certain amount of misconception is perceptible among scientists outside Russia. Planning does not mean that every minute detail of scientific research is laid down beforehand in a Government

Department. The State determines the broad outlines of scientific development in relation to the urgent requirements of practical life. The striking success achieved through planning must be ascribed to the circumstance that plans are not primarily formulated at the highest level and imposed on the workers; component parts are first prepared by workers which are unified and finalised into a well-knit plan at the top for adoption by the nation. The plans from individual institutes are co-ordinated by the appropriate People's Commissariats and passed on to the State Planning Commission, which in consultation with the Academy of Sciences, consolidates them into a national plan. It is finally scrutinized by the Council of People's Commissars of the U. S. S. R. before it emerges out as a State plan. Planning eliminates duplication of work, and the waste of effort and funds it entails. It focusses attention on the needs and requirements of the people and ensures concentrated effort on a defined set of objectives. Judged by the results, planning has been an unqualified success. The striking advances in science and the phenomenal development of the material resources, have all been secured under the successive Five-Year Plans. It is under the ægis of these plans that numerous scientific expeditions have set out to different parts of the country and discovered and chartered new resources. The work of the geological expeditions have altered the entire conception of the material wealth of the country. The results of the famous Papanin expedition to the Arctic regions, and of the numerous biological and archæological expeditions are widely known, and they have greatly enhanced the prestige of Soviet science.

The growth of science under the direction of the Academy of Sciences, is greatly influenced by the philosophy of Dialectical Materialism, originated by Marx and Engels and developed by Lenin and Stalin. It ascribes priority to matter, the objective world. Ideas and thoughts, whose importance is by no means minimized, are secondary and are useful only in so far as they influence material changes. This concept elucidates the Soviet attitude towards *pure* and *applied* science. "That which we know as *applied* science is applied sooner. That which we know as *pure* science is applied later, but is none the less important for that." Says Prof. Kapitza, "Great science (by which

is meant *pure science*) is that science which studies essential phenomena necessary for the most profound knowledge of nature... The task of science is to give the necessary knowledge for transforming nature so that it can serve man in his cultural development."

The Academy of Sciences is the guiding centre of scientific action in the U. S. S. R. Under its expansive wings science has reached great heights. Numerous institutes for the intensive study of specific departments of knowledge, including humanities, have been started under its ægis. Special institutes have been built for outstanding scientists. Individual ability is recognized and encouraged. Well-equipped laboratories provide ample facilities for the activities of the working

scientist. Science has flourished rapidly and its prestige and influence are higher in Russia than in any other country. During the recent crisis, the Academy was able to mobilize all the resources effectively and adequately, and it should be mentioned in this connection, that Russia was the only country in the world which was not called upon to improvise emergency organizations to mobilize scientific effort for military purposes. Science is a living force in Soviet Russia continuously striving to enrich human life. We join the scientists who assembled in Moscow and Leningrad in paying our humble tribute to the great organization which has played so distinguished and conspicuous a part in the advancement of science and culture.

PATENTS AND DESIGNS (AMENDMENT) ACT, 1945

BETTER PROTECTION FOR INVENTIONS

THE Indian Patents and Designs (Amendment) Act, 1945, recently passed by the Indian Legislature, deals with matters which should be of considerable interest to those engaged in scientific and industrial research. The "Statement of Objects and Reasons" of the said Act reads as follows:—

"The existing provisions of the Indian Patents and Designs Act, 1911, do not permit an inventor to apply for a patent before he has worked out the practical details of his invention, and thereby expose him to the risks arising from the disclosure of his invention to others at its unprotected stage. The relevant provisions under the U.K. Act, on the other hand, enable the inventor to apply for a patent as soon as the inventive idea occurs to him, and allow him a period of 13 months from the date of his application for developing its practical side, this period being part of the period during which the invention is 'provisionally protected.' It has been found necessary, therefore, to amend the Indian Act on the lines of the U.K. Patents and Designs Act, 1907, so as to confer on the applicant an option to file with his application a 'provisional' specification merely describing 'the nature of the invention' and later, within a specific period, to follow it up with the 'complete' specification describing both 'the nature of the invention' and 'the manner of performing the same.'"

The main object of the new legislative measure is, as mentioned in the above quoted statement, to permit applicants for patents to file their applications accompanied by a *provisional* specification, instead of a *complete* specification as hitherto.

In a *provisional* specification, the applicant is required to give merely a general description of the invention for which protection is sought. It is enough if the description is such as would enable one to ascertain the identity of the invention, when, later, a *complete* specification is filed by the applicant. It is not necessary for him to give minute details of the invention, or a description of the means of putting the invention into use, or a carefully drafted statement of claim, which would accurately define the scope of the protection sought by him. In short, a description in terms in which the inventor would ordinarily describe the inventive idea which has occurred to him, would constitute a fair draft of a *provisional* specification; and therefore, the *provisional* specification may be regarded as a document which may be drafted by any inventor who can express his ideas in intelligible English, and which does not call for a high degree of skill or experience in drafting patent specifications. A *complete* specification is altogether different from a *provisional* specification, from all the standpoints discussed above. An applicant is required to give in a *complete* specification not merely a general description

of the invention, but the details of the invention with all particularity. He is required, moreover, to describe with particularity "the manner of performing the invention," and to include a "statement of claim carefully defining the scope of the monopoly claimed by him." The *complete* specification is, therefore, a document which calls for a high degree of skill and experience, and which should preferably be drafted with the help of patent agents. Moreover, as it calls for details and particulars, it can be prepared only after the inventor has perfected the invention to the extent necessary for working it practically.

From the aforesaid distinctions between the *provisional* specification and the *complete* specification, it is easy to appreciate that the new piece of legislation provides greater facilities to inventors to safeguard the validity of their patents, and to make speedy arrangements for the exploitation of their patents. The facilities in question may be briefly stated as follows :—

- (1) As an application for patent may be made before working out the practical details of the invention, inventors would be able to apply for the patents as soon as inventive ideas occur to them. Thus, they would be able to secure earlier priorities for their patents than has been the case hitherto.
- (2) As protection would accrue from the date of filing the application accompanied by a *provisional* specification, inventors would be able to work out the practical details of their inventions without fear of piracy.
- (3) For the same reasons, they would be able to test the commercial possibilities of their inventions and arrange for the commercial working of the same, not only very much earlier than at present, but also with the confidence that if, while doing so, there be any inadvertent disclosure of their inventions to others, it would not invalidate their patents.
- (4) In the case of inventors who cannot afford to engage patent agents for drafting the *complete* specification properly, the filing of a *provisional* specification in the first instance, would make it safe for them to disclose

their inventions to potential backers, who, with a view to take over the invention for commercial exploitation, would be prepared to meet the expenses involved in engaging competent patent agents for drafting the *complete* specifications. Thus, it would be possible even for needy inventors to arrange for professional help for securing the maximum protection for their patents, without running the risks involved in disclosing the invention to others before provisionally protecting it.

- (5) If the inventors find that their experiments or negotiations are not promising of success, and therefore decide to abandon their applications, the loss incurred by them would be much less than if they had to file *complete* specifications in the first instance, as the initial fee and other expenses for filing an application accompanied by a *provisional* specification are very much less than those for an application accompanied by a *complete* specification.
- (6) As an incidental measure, the new legislation provides also that in respect of various improvements or modifications of one and the same invention, an inventor can file any number of *provisional* specifications, and that by combining them together in a single *complete* specification, *obtain a single patent* for all these modifications. Inventors would thus be saved the trouble and the expense involved in taking out a multiplicity of patents for protecting the various improvements and modifications worked out by them from time to time during the interval between the date of the first *provisional* specification and the date of the *complete* specification.

It is understood that rules for implementing the new Act are under preparation, and that the scheme for filing *provisional* specification would be brought into operation with the least possible delay. There is no doubt that inventors would welcome the new legislation and make full use of the facilities afforded by it.

(Contributed)

PERIODIC STRUCTURES IN THE COAGULATION OF RUBBER LATEX

By GEORGE T. VERGHESE AND M. A. GOVINDA RAU

(Indian Institute of Science, Bangalore)

THE systematic investigation of the phenomenon of periodic structures was first made by Liesegang^{1, 2} in 1896. Since then interest in the study of this phenomenon has continued unabated; it has been demonstrated by experiments under varying conditions such as reactions in the absence of a gel medium, reactions in gaseous systems, coagulation by salts, etc.

The majority of experiments on Liesegang phenomena have been carried out in a gel medium, like agar or gelatin. But during recent years several instances of periodic structures in the absence of any gel medium have been reported,³⁻⁸ which clearly indicate that the gel medium is not essential for the formation of Liesegang rings.

While investigating the action of coagulating agents on rubber latex it was noticed that periodically coagulated structures were produced by the action of suitable coagulants. Rubber latex is essentially a colloidal emulsion, and consists of particles varying in size from 0.5 to 2 μ . These particles are negatively charged. The colloidal emulsion of latex is generally stabilized by the addition of about 0.75 per cent. ammonia in the plantations, and thus preserved for future processing. Henri⁹ has studied the action of several coagulants on ammonia-preserved latex, and has come to the following conclusions: (1) coagulation by electrolytes is determined by the positive ions of the electrolytes; (2) salts of monovalent metals are without effect; (3) salts of metals such as calcium, barium, magnesium, when present in a concentration of not less than 1 N. produce coagulation; (4) salts of heavy metals such as manganese, nickel, cobalt, copper, zinc, aluminium and lead, produce agglutination when present in a concentration of 0.05-N.

In our experiments on Liesegang phenomena in rubber latex, it was found that when a drop of zinc chloride solution was placed at the centre of a thin film of rubber latex spread out on a glass plate, well-defined concentric rings were formed; and this phenomenon could easily be reproduced. Photographs of a few ring

systems obtained with some coagulants are shown in Fig. 1 (1, 2, 3, and 4). It was, however, difficult to develop a large number of rings because the latex film on the glass plate got solidified in a short time and ring formation consequently stopped. The trouble could not be overcome even when the film was kept in air saturated with water vapour. In the best specimen that was prepared, there were about half a dozen rings. Further experiments were therefore conducted with latex contained in narrow glass tubes of 2 to 3 mm. dia., open at one end, and the coagulant diffusing into the latex as an external electrolyte.

Experimental

A glass tube, 3. mm. dia. and 10" long, was filled with ammonia-preserved rubber latex of a D.R.C. of 30 per cent. One end of the tube was closed by means of a rubber tube and a pinch cock. The open end of the tube was kept just touching the surface of a 15 per cent. solution (20 cc.) of zinc chloride contained in a beaker. This arrangement was kept undisturbed for 24 hours, at the end of which period the tube was taken out and examined. A solid coagulum of rubber weighing about 0.6 grams when wet (and half this weight when dry) was observed. But no rings could be identified. The dry rubber content of the uncoagulated latex in the glass tube was determined in the usual manner, and was found to be about 23 per cent.

The same experiment was repeated by using a 7 per cent. solution of zinc chloride. On examining the system after 24 hours some twelve rings or stratifications were observed, in the coagulum of rubber that was formed at the open end of the tube. The distance between the successive rings was measured by means of a cathetometer.

Keeping the concentration of latex the same, other concentrations of zinc chloride, viz., 3 per cent. and 1 per cent. were tried. In these two instances also the same type of stratifications as mentioned above was observed.

The time of immersion of the tube containing the rubber latex in the zinc

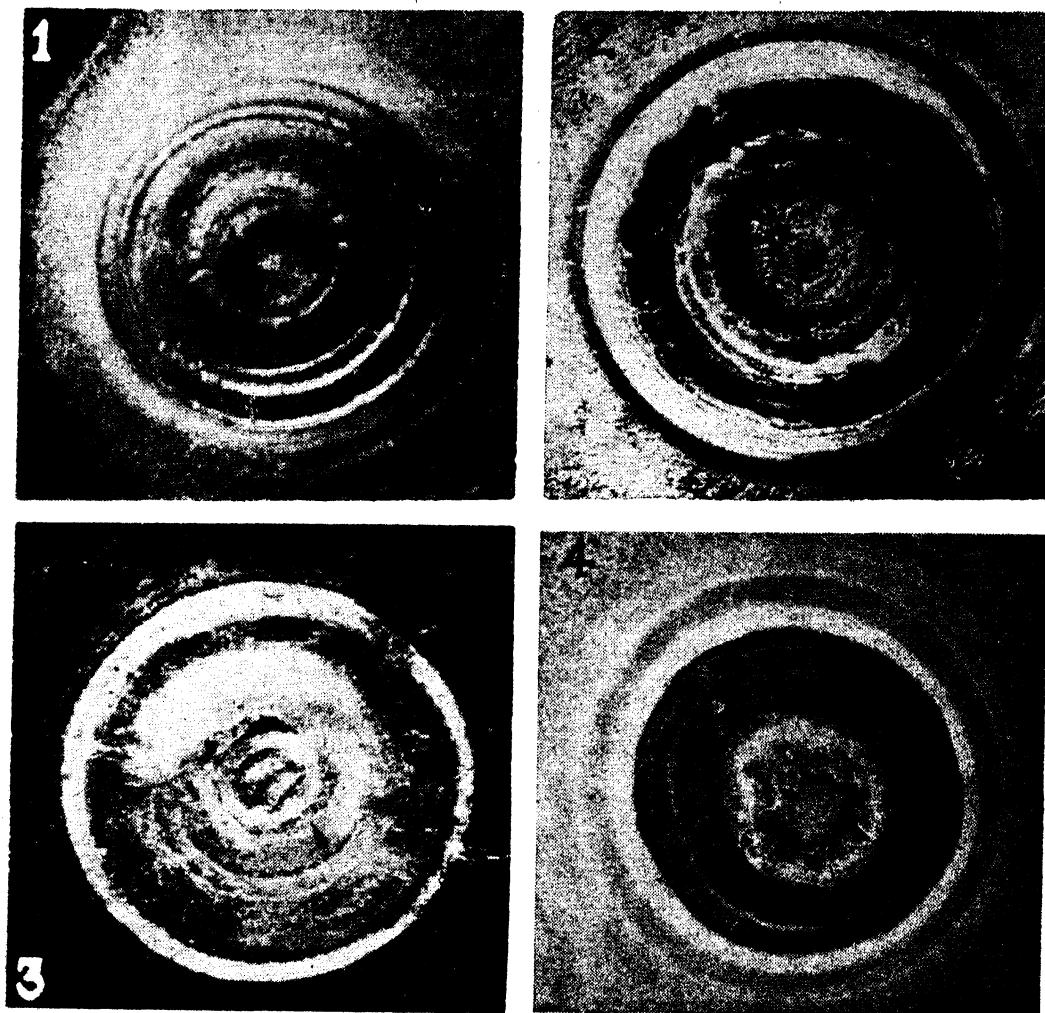


Fig. 1.—Periodic structures in rubber latex of 30 per cent. DRC produced on glass plates.

- | | |
|---|--|
| (1) With zinc chloride solution (15 per cent.). | (2) With magnesium chloride solution (15 per cent.). |
| (3) With zinc sulphate solution (30 per cent.). | (4) With magnesium sulphate solution (30 per cent.). |

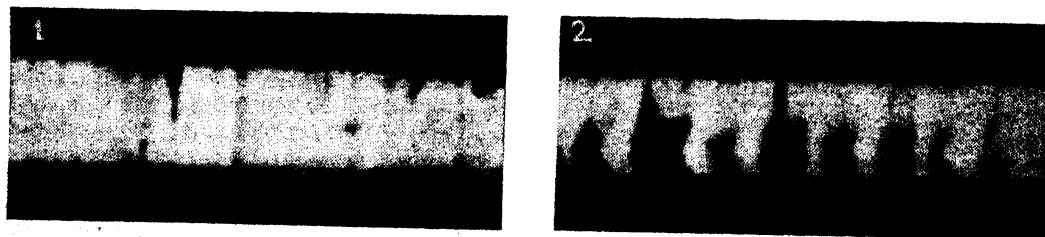


Fig. 2.—Periodic structures in rubber latex of 15 per cent. DRC produced in glass tubes.

- | | |
|---|--|
| (1) With zinc chloride solution (15 per cent.). | (2) With magnesium chloride solution (15 per cent.). |
|---|--|

TABLE I. *Effect of different concentrations of zinc chloride solution on the formation of rings.*

No.	Original DRC of latex	Concentration of ZnCl ₂ soln.	Time of immersion	Wt. of coagulum obtained	Final DRC of latex	No. of rings	Distance between successive rings beginning from open end of the tube	Average value of <i>l</i>
	%	%	hrs.	gm.	%		mm.	
1	30	15	24	0.6	23.4	nil	Too close to be identified individually.	....
2	30	7	24	0.4	25.5	9	0.24, 0.32, 0.40, 0.48, 0.56, 0.72, 0.72, 0.80	1.18
3	30	3	24	0.3	26.9	6	0.24, 0.32, 0.48, 0.64, 0.8	1.35
4	30	1	24	0.2	27.6	2	0.24	....
5	30	15	48	0.8	21.6	nil	Too close to be identified individually.	....
6	30	7	48	0.5	23.6	14	0.32, 0.32, 0.56, 0.88, 1.12, 1.36, 1.52, 1.60, 1.76, 1.92, 2.08, 2.24, 2.32	1.19
7	30	3	48	0.4	25.8	8	0.40, 0.48, 0.64, 0.96, 1.28, 1.92, 2.72	1.38
8	30	1	48	0.3	26.8	4	0.24, 0.32, 0.48	1.59
9	15	15	24	0.5	12.7	7	0.40, 0.48, 0.64, 0.96, 1.44, 2.08	1.39
10	15	7	24	0.4	12.9	6	0.80, 0.80, 0.96, 0.96, 1.28	1.13
11	15	3	24	0.2	13.4	3	0.64, 0.96	1.50
12	15	15	48	0.8	12.4	9	0.40, 0.80, 0.80, 1.20, 1.60, 2.00, 2.40	1.33
13	15	7	48	0.5	12.8	7	0.40, 0.40, 0.80, 1.20, 2.00, 2.00	1.41
14	15	3	48	0.3	13.2	3	0.8, 0.96	1.20
15	7	15	24	0.3	5.8	3	0.64, 0.80	1.25
16	7	7	24	0.1	6.0	2	0.32	....
17	7	3	24	....	6.9	nil	....	....
18	7	15	48	0.5	5.3	6	0.32, 0.64, 0.80, 0.96, 1.12	1.40
19	7	7	48	0.2	5.6	3	0.48, 0.64	1.33
20	7	3	48	....	6.9	nil	....	....

Table II gives the results of experiments employing zinc sulphate solution as coagulant. Results obtained with other coagulants,—cadmium chloride, magnesium chloride and barium chloride are given in Tables, III, IV and V respectively.

TABLE II. *Effect of different concentrations of zinc sulphate solution on the formation of rings.*

No.	Original DRC of latex	Conc. of ZnSO ₄ solution	Time of immersion	Wt. of coagulum obtained	Final DRC of latex	No. of rings	Distance between successive rings beginning from open end of tube	Average value of <i>K</i>
	%	%	hrs.	gm.	%		mm.	
1	30	15	24	0.15	29.	3	0.40, 0.64	1.60
2	30	7	24	0.10	29.5	3	0.56, 0.80	1.43
3	30	3	24	0.05	29.8	1	....	....
4	30	15	48	0.25	28.3	4	0.40, 0.64, 0.96	1.35
5	30	7	48	0.20	28.5	3	0.56, 0.80	1.43
6	30	3	48	0.10	29.2	2	0.64	....
7	15	15	24	0.1	29.4	2	0.48	....
8	15	7	24	....	29.9	nil	....	....
9	15	15	48	0.2	28.8	3	0.48, 0.64	1.33
10	15	7	48	0.1	29.4	2	0.48	....
11	15	3	48	....	29.8	nil	....	....
12	7	15	24	....	29.8	nil	....	....
13	7	15	48	0.05	29.6	1	....	....

chloride solution was then doubled, and the experiments repeated.

The concentration of rubber latex was next decreased to 15 per cent. and 7 per cent. and the experiments repeated.

The results obtained are given in Table I.

It was noticed, however, that in these experiments distinctly separated rings were not produced but the coagulum consisted of a continuous and "crimped" filament. A few structures obtained in these experiments are shown in Fig. 2. (1 and 2).

Discussion

A number of theories have been advanced from time to time to explain the phenomenon of periodicity. In some of these the gel medium is given great prominence, while in others the gel assumes only a secondary role. All the theories required the attainment of a critical or threshold condition by the reacting substances. Thus, Wi. Ostwald¹⁰ assumes the existence of a metastable limit at which the precipitate is thrown down. Bradford¹¹ claims that due to the adsorption of the inner electrolyte by the precipitate,

TABLE III. *Effect of different concentrations of cadmium chloride solution on the formation of rings.*

No.	Original DRC of latex	Conc. of CdCl ₂ soln.	Time of immersion	Wt. of coagulum obtained	Final DRC of latex	No. of rings	Distance between successive rings beginning from open end of tube	Average value of K
	%	%	hrs.	gm.	%		mm.	
1	30	30	24	0.6	23.3	nil	Only solid coagulum	...
2	30	15	24	0.4	24.6	8	0.16, 0.32, 0.48, 0.64, 0.64, 0.80, 0.96	1.38
3	30	7	24	0.3	25.5	5	0.16, 0.32, 0.64, 0.80	1.74
4	30	3	24	0.1	26.5	2	0.32	...
5	30	15	48	0.8	23.2	12	0.16, 0.32, 0.32, 0.48, 0.64, 0.80, 0.8, 0.96, 1.12, 1.28, 1.38	1.29
6	30	7	48	0.5	24.4	8	0.32, 0.48, 0.48, 0.64, 0.80, 0.96, 0.96	1.21
7	30	3	48	0.4	25.1	6	0.16, 0.32, 0.64, 0.80, 0.96	1.18
8	15	30	24	0.4	13.3	8	0.16, 0.32, 0.32, 0.48, 0.64, 0.80, 0.96	1.18
9	15	15	24	0.3	13.7	6	0.16, 0.32, 0.48, 0.48, 0.64	1.45
10	15	7	24	0.1	14.2	3	0.32, 0.48	1.50
11	15	30	48	0.6	13.0	13	0.16, 0.32, 0.48, 0.48, 0.64, 0.80, 0.80, 0.96, 1.12, 1.20, 1.28, 1.44	1.29
12	15	15	48	0.4	13.4	7	0.32, 0.32, 0.48, 0.64, 0.80, 0.96	1.55
13	15	7	48	0.2	13.8	5	0.16, 0.32, 0.48, 0.64	1.65

TABLE IV. *Effect of different concentrations of magnesium chloride solution on the formation of rings.*

No.	Original DRC of latex	Conc. of MgCl ₂ soln.	Time of immersion	Wt. of coagulum obtained	Final DRC of latex	No. of rings	Distance between successive rings beginning from open end of tube	Average value of K
	%	%	hrs.	gm.	%		mm.	
1	30	30	24	0.7	23	10	0.32, 0.32, 0.64, 0.96, 1.28, 1.44, 1.44, 1.60, 1.60	1.25
2	30	15	24	0.4	25.2	6	0.32, 0.64, 0.80, 0.96, 1.28	1.44
3	30	7	24	0.3	25.8	4	0.32, 0.64, 0.96	1.70
4	30	30	48	1.0	22.5	16	0.32, 0.64, 0.96, 0.96, 1.28, 1.44, 1.60, 1.60, 1.76, 1.78, 1.92, 2.08, 2.08, 2.24, 2.24	1.33
5	30	15	48	0.7	23.1	10	0.32, 0.64, 0.80, 0.96, 1.28, 1.44, 1.44, 1.60, 1.76	1.26
6	30	7	48	0.5	23.6	8	0.32, 0.64, 0.80, 0.96, 0.96, 1.28, 1.44	1.31
7	15	30	24	0.3	13.8	6	0.48, 0.64, 0.96, 1.28, 1.28	1.24
8	15	15	24	0.2	14.1	3	0.32, 0.64	2.00
9	15	7	24	0.1	14.4	2	0.32	...
10	15	30	48	0.5	13.2	8	0.48, 0.64, 0.96, 0.96, 1.28, 1.44, 1.44	1.21
11	15	15	48	0.3	13.8	5	0.32, 0.64, 0.80, 0.96	1.10
12	15	7	48	0.2	14.2	3	0.32, 0.64	2.00

TABLE V. *Effect of different concentrations of barium chloride solution on the formation of rings.*

No.	Original DRC of latex	Conc. of BaCl ₂ soln.	Time of immersion	Wt. of coagulum obtained	Final DRC of latex	No. of rings	Distance between successive rings beginning from open end of tube	Average value of K
	%	%	hrs.	gm.	%		mm.	
1	30	30	24	0.5	24.0	7	0.32, 0.48, 0.64, 0.64, 0.80, 0.96	1.25
2	30	15	24	0.3	24.6	4	0.32, 0.48, 0.64	1.41
3	30	7	24	0.1	25.2	2	0.32	...
4	30	30	48	0.7	23.8	10	0.32, 0.48, 0.48, 0.64, 0.80, 0.96, 0.96, 1.12, 1.28	1.05
5	30	15	48	0.5	24.0	6	0.32, 0.48, 0.64, 0.64, 0.80	1.27
6	30	7	48	0.3	24.4	4	0.32, 0.48, 0.64	1.41
7	15	30	24	0.4	24.2	4	0.32, 0.48, 0.64	1.41
8	15	15	24	0.2	24.5	3	0.16, 0.32	2.00
9	15	7	24	0.1	25.1	1	...	...
10	15	30	48	0.6	23.7	6	0.32, 0.48, 0.64, 0.64, 0.80	1.27
11	15	15	48	0.4	24.1	4	0.32, 0.48, 0.64	1.41
12	15	7	48	0.2	24.6	3	0.16, 0.32	2.00

the outer electrolyte will have to travel a certain distance before it can contact the inner electrolyte at the critical concentration. Wo. Ostwald¹² postulates that a critical state of chemical equilibrium is reached periodically through the interference of diffusion waves. Dhar and Chatterji¹³ maintain that a critical concentration of the electrolyte causes coagulation of the colloid. Freundlich¹⁴ has advanced another theory of coagulation to explain the periodic phenomenon. According to this theory the diffusion of the electrolyte as also the formation of sufficient number of nuclei are responsible for bringing about the critical condition for coagulation.

The ring formation reported here is caused by the purely physical process of coagulation. The characteristic periodic structures observed are very similar to those reported by Hedges¹⁵ by direct coagulation of arsenious sulphide sol in the absence of a gel. Here also definite bands of precipitate were not obtained, but only a filamentary coagulum of a wavy nature, which was reported as "a new kind of periodic structures which may be of interest in connection with the waviness of many natural colloidal fibres such as wool."

The origin of this "crimped filament" structure is most probably connected with the well-known polydisperse nature of the latex emulsion, with particle sizes ranging from 0.5 to 2 μ . Indeed, the observations recorded in this paper will constitute a striking support to the idea originally put forward tentatively by Hedges¹⁶, relating the crimped and similar periodic structures with possible differences in mobility of colloidal particles present or formed. The more mobile fraction diffuses towards the coagulating zone and accumulates to form a thicker ring, leaving a depleted region containing the less mobile, larger sizes to be coagulated into a filament of thinner cross section by the steadily advancing electrolyte. Thus thicker and thinner cross sections are formed periodically.

With a rapidly diffusing electrolyte of higher concentration, the counter diffusion of the mobile fine fraction is overwhelmed and only a solid coagulum of uniform cross section results. With weaker concentrations, the diffusion rate is compatible with that of the mobile particles, and a very clear set of rings is produced, and the rings are naturally spaced out more and more away

from the electrolyte end. With very weak electrolytes of slow diffusion rate, few rings, if any, are formed.

For periodic structures Jablczynski¹⁷ has shown that the relation $K = \frac{Y_n}{Y_{n-1}}$ where Y_n is the displacement of the n th ring, Y_{n-1} is the displacement of the $(n-1)$ th ring, and K is a constant, holds good. Tables I to V indicate that the average distance between the successive rings increases in the direction of diffusion of the electrolyte. The value for K as calculated by the above equation is found to be approximately constant for the different experiments.

Summary

(i) Periodic coagulation of rubber latex provides an example of the occurrence of periodicity in a colloidal system in the absence of a gel medium.

(ii) The number of stratifications obtained increases with increasing concentration of the colloid and the salt solution.

(iii) The distance between consecutive rings increases in the direction of diffusion of the salt.

(iv) The above observations can be correlated with the polydisperse nature of the latex emulsion, and the consequent differences in the mobility of the particles.

The authors' thanks are due to Sir Jnan Chandra Ghosh, Kt., D.Sc., F.N.I., for his keen interest in this work, and to Dr. M. R. Aswathanarayan Rao, D.Sc., for some helpful suggestions. Their thanks are due also to the *Council of Scientific and Industrial Research* for the award of a grant for a specific investigation with rubber latex which enabled the authors to study this phenomenon.

References

- ¹ *Naturwiss. Wochenschr.*, 1896, **11**, 353.
- ² *Phot. Archiv.*, 1896, 221.
- ³ *J. Biol. Chem.*, 1923, **58**, 415.
- ⁴ *Kolloid Z.*, 1926, **40**, 144.
- ⁵ *Proc. Royal Irish Acad.*, 1929, **38B**, 485.
- ⁶ *J. Phys., Chem.*, 1930, **30**, 1554.
- ⁷ *Ibid.*, 1931, **35**, 1512.
- ⁸ *Nature*, 1932, **129**, 761.
- ⁹ *Le Caoutchouc*, 1906, 106; 1908, 2405.
- ¹⁰ *Z. Physik, Chem.*, 1897, **27**, 265.
- ¹¹ *Biochem. J.*, 1917, **11**, 14.
- ¹² *Kolloid Z.*, 1925, **36**, 380.
- ¹³ *J. Phys. Chem.*, 1924, **28**, 41.
- ¹⁴ *Z. Physik. Chem.*, 1913, **85**, 677.
- ¹⁵ *J. Chem. Soc.*, 1929, 2781.
- ¹⁶ *Liesegang Rings*, Hedges: Chapman and Hall, 1932, p. 71.
- ¹⁷ *Bull. Soc. Chim.*, 1923, **33**, 1592.

EXTRACTION OF SODA FROM LONAR LAKE

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LONAR Lake is situated in the Buldana District of the province of C.P. and Berar. It lies in the basaltic region and is widely known as an important and natural source of soda. The lake has attracted much attention as indicated by several references to it in literature.¹ Data relating to the analyses of the salts that separate spontaneously on the shores of the lake have been published from time to time¹. The soda of the Lonar basin occurs partly in the shallow lake in the middle of the depression which is believed to be of volcanic origin, and partly in the alkaline mud covering the whole floor of the hollow. Crude soda has been recovered from the lake for centuries. The methods employed appear to have varied considerably from time to time, as the descriptions by various observers are by no means concordant.

When the lake water recedes by evaporation in the hot season, a whitish incrustation known as *bhushi* is left on the shores. This is contaminated with decomposed algæ and other organic matter, and with a large quantity of earthy impurities. As the evaporation progresses with advancing summer, another salt called *papri* often separates out in thicker incrustations. The average compositions of the air-dried salts, as determined by us employing standard methods of analysis², are as follows :—

TABLE I. Percentage composition of "*Bhushi*" and "*Papri*."

Salt	NaCl	Na ₂ CO ₃	NaHCO ₃	Insolubles
Bhushi	1.41	22.50	18.90	57.10
Papri	20.95	36.13	22.12	21.00

As regards the total quantity of soda available in the Lonar basin, the estimates available appear to be out of date. The method adopted by us for estimating the soda content is as follows :—

The lake water was analysed before and after the rainy season, in the months of June and September 1944. At the same time, the levels of water were carefully recorded.

The difference between the two levels was found to be 2'.

Analysis of lake water

	Na ₂ CO ₃	NaHCO ₃	NaCl
June 1944	2.17	0.98	5.03
September 1944 ..	0.71	0.36	1.59

Owing to the dilution caused by rain water in the monsoon season, the concentrations of salts in the lake fell down in September. The relative concentrations of each salt in September and June are :—

Na₂CO₃; 1: 3.06

NaHCO₃; 1: 2.70

NaCl; 1: 3.16

The ratios for Na₂CO₃ and NaCl are nearly the same, but not so for NaHCO₃. It is reasonable to assume that an extra amount of NaHCO₃ has appeared in the lake along with rain water. Such an occurrence is quite likely in view of the fact noted by Christie that the sub-soil water is richer in NaHCO₃ than in other salts.

The area of the lake, according to the C.P. Government Survey, is 344 acres and 38 gunthas. The surface area of the lake water necessarily varies according to seasons ; we estimate the mean surface area as 200 acres.

Let X tons of water be present in June 1944 when NaCl=5.03 per cent.

Then total amount of NaCl in the lake will be 0.0503 X tons (i). In September 1944, the water level rose by 2'. The quantity of water added by rain is given by:

mean surface area x increase in level
= 200 x 43,560 x 2 cu. ft. (acre=43,560 sq. ft.)

= $\frac{200 \times 43,560 \times 62.34 \times 2}{2,240}$ = 484,932 tons.

(the density of the lake water=62.34 lbs. cu.ft.)

The total quantity of water in September 1944 will be

$X + 484,932$ tons.

∴ The amount of NaCl present
 $= (X + 484,932) 0.0159$ tons (ii)

Assuming that the total NaCl content of the lake does not appreciably vary and equating (i) and (ii), we have

$$0.0503 X = (X + 484,932) 0.0159$$

$$\text{or } X = 222,977.$$

The quantities of water in the lake in June and September are 222,977 and 707,909 tons respectively and the amounts of salts in the lake water in the two months are:—

	Na ₂ CO ₃ Tons	NaHCO ₃ Tons	NaCl Tons
June	4,839	2,185	11,216
September	5,026	2,549	..

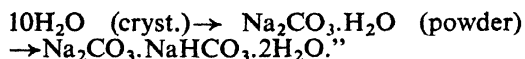
In terms of Na₂CO₃, the soda content comes to about 6,635 tons. The method adopted is preferable to the one of directly estimating the soda content, as the average depth cannot be easily determined, as some spots in the lake are believed to be unfathomable.

LaTouche and Christie state, however, that the water in the lake was nowhere more than 2' deep¹. This statement is in conflict with the earlier reports. The *Buldana District Gazetteer* quoting Mackenzie states : " . . . that the crater . . . has towards the western side (rather than the centre) two openings, hitherto unfathomed, . . . " The description of the spots unfathomed is also given.³ One of us (V.P.P.) has observed that Mackenzie's statement is correct, as the depths at the spots mentioned cannot be ascertained by ordinary methods.

Mode of Formation of *Bhushi*

The mode of formation of *Trona* or *Urao* in other similar inland lakes has been explained as follows⁴ :—

"Water carrying soda in solution in the lake gets concentrated by natural evaporation due to the dryness of the climate, the scarcity of rain, and the presence of more or less constant winds in such open places. Concentration of soda in the water becomes so great that during cold weather, sal soda begins to crystallize out on the surface of the marshy ground. The upper layer of the sal soda deposit gradually effloresces in contact with the atmosphere and loses much of its water of crystallization, forming the white powdery monohydrate Na₂CO₃.H₂O. This then in turn is gradually converted by atmospheric H₂O + CO₂ to the sesquicarbonate as the ultimate stable form. Thus, Na₂CO₃ (dissolved) → Na₂CO₃.



This theory does not appear to be applicable to the formation of *Bhushi* at Lonar, as its formation is not a result of high salt concentration as required by the theory. Further, contrary to the theory, *Bhushi* is formed not in the cold weather, but in the hot season.

In June 1944, *Bhushi* had begun to appear but not *Papri*. The formation of *Bhushi* is more common than *Papri*. The concentration of water was not high enough to reach the saturation point of any of the three salts, even after taking into consideration the effect of the common ion; yet *Bhushi* is deposited much below the saturation point. A sample of the lake water itself was evaporated by solar heat in a glass tank and no such separation took place even at somewhat higher concentrations than those obtaining in the lake. *Bhushi* formation appears to be facilitated by the clay present in the lake floor. Examination of the clay indicates that it has a high capacity for adsorbing sodium carbonate and as reported by Christie¹, the mud in the lake basin itself contains a large quantity of soda. The mechanism of the formation of *Bhushi*, and the part played by the mud therein are under investigation.

There is evidence to suggest that *Bhushi* is synonymous with *trona* or *urao* (Na₂CO₃.NaHCO₃.2H₂O). The relative proportions of Na₂CO₃ : NaHCO₃ in the latter salt are 106:84, i.e., 22.5:17.83, whereas in *bhushi* the ratio is 22.5:18.9, which is in close agreement with that of *urao* or *trona*.

In order to establish an economic plant, the factors in favour of the lake as well as against it have been carefully considered. The odds against the lake are :—

- (1) the limited resources of the lake,
- (2) heavy transport charges by motor road to the nearest railway station,
- (3) absence of cheap power, and
- (4) scarcity of fuel.

The points in favour of the lake are :—

- (1) the simple occurrence of *Bhushi* or *Papri*, fairly low in sodium chloride;
- (2) negligible amount of Na₂SO₄ in the lake water;
- (3) natural advantages due to the favourable location of the lake permitting rapid solar evaporation; and
- (4) cheap labour.

The question of transport by rail is not serious as the lessee, *Messrs. Shree Onama Glass Works*, situated at Gondia, can profitably consume all the soda for their glass works, as otherwise they are required to import soda from Bombay, a much longer distance compared to that from Khamgaon (the nearest railway station for Lonar).

There are two possible ways of extracting the soda. One of them is to start with the lake water and the other is to purify the *Bhushi* or *Papri*. Since the lake brine is very dilute even in summer, the processing of the lake brine involves a large capital outlay. Recovery of soda from *bhushi* or *papri* is less expensive and their treatment necessitated our first consideration.

Before trying the process proposed here, a critical examination of the various possible methods of extraction of soda was made. The processes that are in use for extracting soda from soda brines in some of the well-known lakes, e.g., Searles and Owens in the U.S.A. are given below :—

Carbonation process :—Lake brine is blended with *trona* and the blended solution is then run into tall wooden towers through which CO_2 is bubbled. NaHCO_3 is produced as a fine granular mass, which is filtered and washed on a rotary filter. It is then dried and calcined in a rotary kiln, from which the CO_2 is recovered for use in fresh carbonation. Theoretically, the plant needs no additional supply of CO_2 ; but, in practice, large losses occur and further supplies of CO_2 are obtained by calcining dolomite found locally⁵.

Refrigeration process :—The concentrated brine is cooled to a temperature of about -20°C . The carbonates separate out (but not NaCl) in a crystalline mass which is filtered and washed on a rotary filter or is centrifuged. It is then dried and calcined⁶.

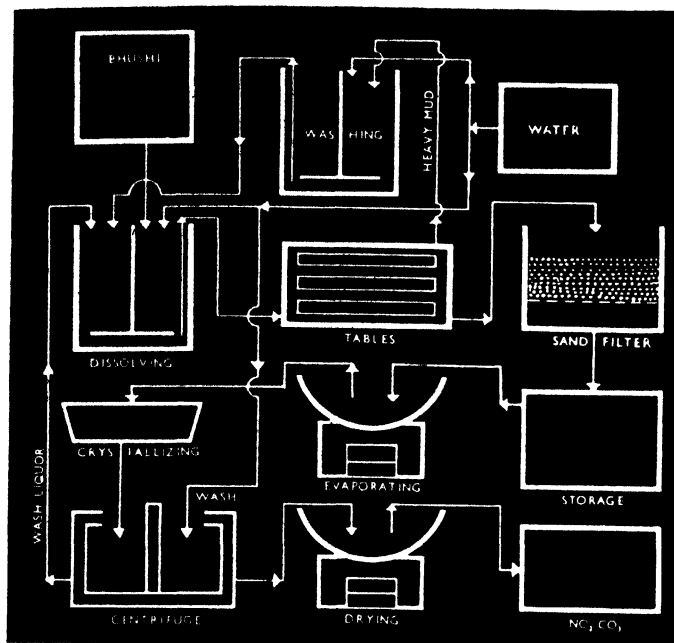
Since the carbonation process needs practically all the equipment used in the Solvay process, the cost of recovering the soda will be practically the same as that of the product obtained by the direct adoption of the Solvay process. Besides, in the case of the Lonar lake, since the resources are limited, only a small scale plant can be established and the carbonation process would be uneconomical. The refrigeration process can be adopted on a small scale; but the required machinery is not available.

A process which does not involve the use of any elaborate machinery has been finally worked out. Isothermal evaporation of the lake brine results in the separation of NaCl in the first instance, as it is present in large proportions (see table of analysis) and a mixture of $\text{Na}_2\text{CO}_3 + \text{NaCl}$ at a later stage. The recovery of soda from the mixed salt so obtained is accomplished by what may be called a *temperature cycle process*⁷. Advantage is taken of the large variation of the solubility of Na_2CO_3 with temperature, in contrast with the small variation of the solubility of NaCl with temperature; by alternate evaporation at high temperature and cooling to room temperature an efficient separation of the two salts can be effected. This process can also be applied for the recovery of soda from *bhushi* and allied salts. The commercial feasibility of the process outlined here has been established by a series of pilot plant trials.

Outline of the Process

Bhushi is collected by hand-picking and stirred up with water in a dissolving tank (see flowsheet diagram). The larger particles of clay are settled out by leading the slurry through long shallow zig-zag troughs called *tables*. A layer of heavier mud accumulates at the upper end and the deposit gradually thins down until the last few feet are free from mud; it still contains some fines in suspension. Due to the presence of alkali, the clay cannot be easily settled out by stagnation alone. Tabling followed by filtration through a sand filter is necessary for rendering the liquor free from insoluble matter. It is a common practice to calcine the crude soda from *reh* and other sources for improving the settling properties of clay. Although this could be adopted for *bhushi*, we discarded it as it was expensive in fuel.

The tables employed were of the gravity concentrator type such as those used in starch making. The separating surface is stationary; the size separation takes place on account of the differential rate of settling in a flowing stream. The mud settling on the tables is transferred to the washing tank and treated with fresh water to recover the adsorbed soda; the weak liquor thus obtained is recycled to treat fresh *bhushi* in the dissolving tank. The washed mud is then rejected. The concentrated liquor, after tabling, contains fines in suspension



Flow Sheet of Process.

and it is filtered through a sand filter of standard specifications. The filtered liquor is then evaporated in direct-fired pans and then allowed to crystallize out fractionally in the crystallizing pan. The crystals are composed of Na_2CO_3 and NaHCO_3 , probably of a composition similar to *urao* or *trona*. The evaporation may, alternatively, be carried out by solar heat in shallow pans of sand lined with non-porous clay, thus eliminating the use of fuel. The crystals are then centrifuged, the adhering impurities, especially NaCl being washed by a fine spray of

water. The wash liquor from the centrifuge contains a certain amount of soda and is employed for treating the *bhushi* in the dissolving tank. The centrifuged material is then calcined in a pan with constant agitation. The final product obtained contains 98 per cent. Na_2CO_3 ; the main impurity is NaCl .

The investigation was subsidized by the lessee of Lonar Lake, Messrs. Shree Onama Glass Works of Gondia and Jubbulpore, with a view to utilize the soda in their glass manufacture. Our thanks are due to them for permitting us to publish a general outline of the process, which is to be adopted by them on a commercial scale. The investigation was carried out at the *Laxminarayan Institute of Technology*, Nagpur University, and our thanks are due to the authorities of the Institute for the facilities provided.

References

- ¹ LaTouche and Christie, *Rec. Geol. Survey, India*, 1911, 41, 266.
- ² T. P. Hou, *Manufacture of Soda* (Amer. Chem. Soc. Monograph Series No. 65, Chemical Catalog Co., New York) 1933, 307.
- ³ C. P. Dist. *Gazetteers, Buldana Dist.*, Vol. A, Edited by A. E. Nelson, Calcutta, 1910, 299.
- ⁴ T. P. Hou, *ibid.*, 329.
- ⁵ Thorpe and Whiteley, *Dictionary of Applied Chemistry* (Supplement, Vol. 2, Longmans Limited, London) 1935, 370.
- ⁶ T. P. Hou, *Roger's Industrial Chemistry*, 1942, Vol. I (Van Nostrand, New York).
- ⁷ Findlay and Campbell, *The Phase Rule and its applications* (Longmans, London) 1940, 276.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(Continued from page 25)

Dr. M. Damodaran (*Madras*): Carbohydrate metabolism in organisms with special reference to the formation of oxalic and citric acids.

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The Tata Oil Mills Co., Ltd. (*Bombay*): Investigations on jasmine aromatics.

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Dr. S. Krishna (*Dehra Dun*): Survey of aromatic plants.

Compilation of the *Dictionary of Economic Products and Industrial Resources of India*.

Letters to The Editor

A CENTRAL BOARD OF STANDARDS FOR INDIA

IT is gratifying to note that Dr. K. N. Mathur has drawn attention to the setting up of a Central Board of Standards¹ for specifying industrial standards and for revising them periodically.

India is one of the few countries which do not have a National Standards Organization so far, while, countries, even like New Zealand, Netherlands, Finland, etc., have their own standards organizations.

The Institution of Engineers (India), since its inception, has been undertaking the work of examining draft *B.S.* specifications and obtaining comments and criticisms from various manufacturers and Government Departments and forwarding them to the *B.S. Institution*, indicating as to how far these specifications need to be amended for Indian requirements. Since 1938, the Institution of Engineers (India) has been trying to form a National Standards Organization in India, but due to the war, this scheme has not fructified.

The question of industrial standardization was discussed at the 12th Industries Conference, at the instance of the Bombay Government, who emphasized the need for a central

organization for this purpose. The resolution of the Industries Conference was considered by the Government of India, and probably due to the war, no action in this connection was taken. The Institution of Engineers (India) have now appointed a sub-committee, with the undersigned as Convenor, consisting of eminent engineers, to go into the question of setting up a National Standards Organization and prepare a scheme to that effect.

It is time, therefore, that a non-official statutory organization termed The Indian Standards Institution similar to the American Standards Association, the British Standards Institution, etc., is formed in India.

The Committee set up by the Institution of Engineers (India) will welcome any suggestions from the readers of your esteemed journal if they are forwarded to the undersigned.

P. R. AGARWAL.

Institution of Engineers (India)
Central India Centre,
22/90, Connaught Circus,
New Delhi, May 19, 1945.

¹ This *Journal*, 1945, 3, 437.

INTERNATIONAL UNITY AND THE RED WOOD TREE

CALIFORNIA hopes to spread its big *Sequoia* trees around the world as a living symbol of the International Unity expressed in the United Nations Charter signed by 50 nations who recently assembled at San Francisco.

Seeds of the General Sherman *Sequoia*, 5,000 years old and 273' high, were distributed to the delegates at San Francisco where the greatest alliance in history was discussed and adopted, an alliance against

war involving the creation of a comprehensive machinery for the prevention of wars by judicial, economic, diplomatic, and, if necessary, military means, and on which the future peace of the world will depend.

The red wood tree, which is believed to be Asiatic in origin, grows to heights of over 300' and lives for more than 4,000 years. The tree can be grown in Mysore, Kashmir, Dehra Dun, Nilgiris, Travancore and other areas in India.

Reviews

LUMINESCENCE IN THEORY AND PRACTICE*

A FAMILIAR way in which a substance may be caused to emit light is by heating it to a sufficiently high temperature. This method, primitive though it seems, is employed on a large scale in the common electric incandescent lamps in which the metal filaments are raised to a high temperature by the passage of a current. A body is said to be luminescent when it is induced to give out light otherwise than by such thermal excitation. Luminescence may arise in various ways, the best known and most common being the emission of visible light under ultraviolet irradiation. There are also other known types of luminescence, e.g., the emission of visible light by certain substances under cathode ray bombardment, by the impact of X-ray or of the α -rays from radioactive material.

Luminescence, again, is broadly of two kinds. The first kind is the light emission observed during the excitation and the other is that which continues when the excitation is removed. These are known respectively as *fluorescence* and *phosphorescence*. The scientific study of these phenomena has been energetically pursued for well over a century and much progress has been made towards the elucidation of their nature. Except, however, in certain special cases, luminescence remained largely a scientific curiosity. During the last decade or so, however, the subject has risen to great practical importance in different directions and especially through the development of what are known as fluorescent lamps. Such lamps are essentially electric discharge tubes with a thin transparent coating of a luminescent material on the interior of the glass walls. The invisible ultraviolet radiation generated by the electric discharge is converted by the coating into visible light. Lamps of this kind are coming into extensive use at the present time. Though they suffer from certain disadvantages, it is likely that owing to their high efficiency they will ultimately play a very large part in the illumination engineering of the future.

Luminescence excited by cathode ray bombardment has found numerous important practical applications, viz., in cathode ray oscillographs, in television receivers and in electron microscopes. The fluorescent screens used in these instruments have been progressively developed to a high degree of efficiency and with the advance of television, further improvements may be expected. The luminescence excited by X-ray finds its principal application in the fluorescent screens used by the radiologist. The luminous dials of watches and clocks make use of the emission of light by certain phosphors when admixed with radioactive material.

Fluorescent and phosphorescent paints have found many applications of a really important nature at the present time. In the dark they make visible certain important points inside buildings or parts of machinery such as switchboards and the like, without spreading light to the other parts of the room. Many other analogous applications of such paints could be mentioned.

Luminescence and especially fluorescence has acquired an important position in chemistry. Especially in analytical chemistry, both organic and inorganic, have methods based on the ability of certain substances to fluoresce achieved a practical value. In particular cases, quantitative methods based on the measurements of fluorescent intensity have also been developed. Fluorescent indicators are likewise coming into use. Fluorescence has also found applications in the testing of the purity of materials and in the technical identification of commercial products. In the tracing of hidden movements or currents of matter in various circumstances fluorescence has found application. Fluorescence microscopes have also been developed in which minute particles are made visible by the light which they emit under ultraviolet irradiation.

Much of the scientific literature on luminescence has been till now in the German language. Mention may be made here of

**Luminescence of Liquids and Solids and its Practical Applications*. By Peter Pringsheim and Marcel Vogel. (Inter Science Publishers, New York). 1944. Pp. x+201. Price \$ 4.00.

two bulky volumes in the *Handbuch der Experimental Physik* dealing exclusively with these subjects written by Lenard and his collaborators. A quarter of a century ago, Professor Pringsheim wrote a treatise on fluorescence and phosphorescence which went into its third edition in the year 1928. He has also contributed a series of articles to various volumes in Springer's *Handbuch der Physik*. It must be said, however, that so far no comprehensive and authoritative presentation of the whole field is available in the English language. It is to be hoped that some day the senior author of the book now under review, would find it possible to undertake the preparation of such an account.

The book now under review is not intended to be a comprehensive treatise on the subject. It leaves out of consideration the phenomena of luminescence in gaseous media. Further, the theoretical aspects of the subject are only touched upon to the extent necessary as an introduction to the experimental facts and the practical applications which form the main theme of the book. These features may possibly be a disappointment to the reader anxious to get a general view of the whole subject. If such disappointment is felt, it would however be largely tempered by the wealth of information gathered and presented in an attractive way regarding the particular aspects covered in the book. The stress laid on the practical applications is fully justified in view of the many and varied developments which have occurred in recent years and which are still in progress.

The book is well printed and well illustrated. To the reviewer, the perusal of the book has been a pleasure and a stimulus to further study and research. He feels sure, that would also be the feeling of every reader of the book interested in this highly important and rapidly advancing field of applied science.

C. V. RAMAN.

Metallurgical Analysis by means of the Spekker Absorptiometer. By F. W. HAYWOOD and A. A. R. WOOD. (Adam Hilger Ltd.), 1944. Pp. xii + 128. Price 18s. net.

With the demand for quick production, the quick checking of qualities also has risen in importance. Of the various physico-chemical tests devised towards this end, the

metallurgical analysis by means of the Spekker Absorptiometer is perhaps the latest. Many of the alloying elements present in both ferrous and non-ferrous alloys when suitably treated, produce coloured compounds (just as the appearance of some colours is known to indicate the end point of certain titration processes in chemical analysis). The increased depth of those colours with increasing percentage of the particular elements are often visually discernible. By matching the colour against those of suitably graded standards, quantitative determinations are often possible. The process described in the book under review is a natural development of the above colorimetric method, but it differs fundamentally from it. Here one actually determines, by means of a photoelectric cell, the amount of light absorbed by the coloured solutions—the absorption having been rendered more sensitive by the use of appropriate filters. The amount of light absorbed is, by Beer's law, proportional to the concentration of the element concerned. We are thankful to Vaughan and his collaborators for the development of much of this technique; their work has been published in the form of two monographs by the *Institute of Chemistry*, in 1941 and 1942. The book by the present authors contains the latest information on the subject.

The book is divided into two parts: the first part deals with the functions, manipulations, and operation of the instrument, and the second with the methods of metallurgical analysis as applied to standard engineering alloys, i.e., ferrous, copper, aluminium and magnesium alloys. The elements in steel and cast iron for which determinations by the new technique have been successful are Cr, Co, Cu, Mn, Mo, Ni, Si, Ti and V; those in copper alloys are Cu, Fe, Mn, Ni and P; in aluminium alloys Al, Cu, Fe, Mn and Si.

The time taken for individual determinations by the Absorptiometer is appreciably small, when carried out in batches, in comparison with that required for analysis by the routine chemical methods. The accuracy is also great, being ± 1 or 2 per cent. There is also a considerable decrease in consumption of chemicals. It thus appears that a great step forward has been achieved in placing in the service of various industries, a quick and accurate method for determining the chemical contents of

different alloys. On examining the list of elements in the ferrous alloys which can be successfully determined by Absorptiometer one finds two important elements, namely, P and W missing (excluding C and S for which rapid combustion methods are available). Phosphorus, on account of the smallness of its content, may require a highly sensitive test, but Vaughan claims to have succeeded in finding such a one—the molybdenum blue reaction with ammonium or sodium molybdate and stannous chloride. The authors of the present book have also employed practically the same method for estimating phosphorus in copper alloys.

Tungsten is an important alloying element for a large variety of steels, the amount employed varying from 2 to 20 per cent. In order to make the Absorptiometer an all-round success for steel analysis, a suitable method for tungsten determination must be found. Neither Vaughan nor Haywood and Wood appear to have succeeded in doing so. They should have mentioned in the book the difficulties experienced in carrying out the determination, so that others interested in the development of a technique may know where to start from.

The fading of colours observed during many analytical processes, emphasizes the need for proper standardization of the procedure, specially in tropical countries.

The book is a valuable addition to the literature on metallurgical analysis.

K. C. MAZUMDAR.

Lecture on Fuels and Furnaces. BY A. K. SHAHA (University Extension Lectures, University of Calcutta), 1944. Pp. 166. Price Rs. 3.

The lectures are mainly based on work carried out by the author in Russia as a research worker in Fuel Technology under the Academician P. P. Lasareff. The first two lectures form the major part of the book and deal with a coke oven and retort for making town gas, and burners for combustion of gaseous fuels. The plates and diagrams illustrating these chapters bear Russian text; a translation into English with detailed description, would have proved really helpful to readers. The third lecture on heat control and measurement of temperature gives little information on these topics; it deals mostly with gaseous flow through tubular channels.

Similarly, the heading of the fourth lecture, viz., control and study of furnace atmosphere, is rather misleading. The chemistry of combustion processes, dealt with in lecture five, should have come logically in the beginning. The last lecture on combustion under constant volume is more or less a misfit in this series. It comes under a distinct branch of study, viz., internal combustion engines.

The book suffers from a strong theoretical bias; theory is not supplemented by information of practical importance. The treatment is somewhat fragmentary and disconnected and for this reason its usefulness to the student of fuel technology and to the furnace engineer has suffered. As stated in the foreword, the style of the author is at many places "somewhat unconventional." The book is to be welcomed with all its shortcomings; it is perhaps the first Indian publication on an extremely important subject, a subject which has hardly received any attention in this country.

Y. P. V.

Rubber Industry in India. By Dr. N. N. GODBOLE, A.I.M.O.. Monograph No. 6 (All-India Manufacturers' Organization, Bombay), 1944. Pp. 24.

An attempt is made in this monograph to survey a wide field in a short space of 24 pages. This ambitious attempt has led to a superficial and perfunctory survey of such subjects as the chemistry of rubber, synthetic rubbers, machinery required for a rubber factory, etc., on each one of which monographs are available in the English language. Surely, no one interested in manufacturing rubber goods would think of consulting the monograph for recipes, which are too cursory to be of value. The author could have more profitably discussed the rubber resources of India and the scope for developing the industry. Monograph 4 in the same series, on the Rayon Industry, is a good model to follow. As it stands, it is difficult to understand which particular profession or trade the author has attempted to enlighten. Perhaps the statistical data are of some value; in a country where there is a paucity of statistical information, any attempt to give a quantitative estimate of production and trade should be welcomed. The monograph is a poor companion to its predecessors.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

THE eighth meeting of the Governing Body of the *Council of Scientific and Industrial Research* was held in New Delhi on 18th March 1945. The Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, presided.

The following schemes of Research were sanctioned :—

New Schemes

- Dr. D. M. Bose (*Calcutta*): Setting up of a medium voltage positive ray discharge tube for the investigation of nuclear disintegration and production of radio-active isotopes.
- Dr. S. A. Saleore (*Nagpur*): Utilization of bauxite deposits of Central Provinces.
- Dr. V. Subrahmanian (*Bangalore*): Chemistry of penicillin and related anti-bacterial substances.
- Prof. H. N. Ray (*Benares*): Manufacture of Seger cones.
- Dr. B. B. Dey (*Madras*): Utilization of waste products of sharks.
- Dr. V. Subrahmaniyan (*Bangalore*): Preparation, properties and utilization of milks from vegetable oil seeds and related materials (copra, groundnut and cashew nut).
- Prof. H. J. Bhabha (*Bangalore*): Cosmic ray research.
- Prof. M. N. Saha (*Calcutta*): Cosmic ray research.
- Prof. D. S. Kothari (*Delhi*): Convection phenomena in the solar atmosphere.
- Mr. B. M. Das (*Calcutta*): Researches on leather.

Extension of Grants

- Sir J. C. Ghosh (*Bangalore*): Manufacture of carbon disulphide.
- Dr. B. B. Dey (*Madras*): Manufacture of Glandular products.
- Dr. Bashir Ahmad (*Delhi*): Preparation of vitamin B₁ concentrates like *Bemax* and *Marmite* and potent strains of yeast.
- Dr. P. C. Guha (*Bangalore*): Preparation of novocaine.
- Dr. M. O. Farooq (*Aligarh*): Chemical examination of the active principles of *Karaaf* seeds.
- Dr. M. C. Nath (*Dacca*): Investigation on steroids with special reference to (1) sex hormone activity of artosteron and other sterol derivatives and (2) vitamin D activity of new steroids,

Dr. B. Mukherji (*Calcutta*): Pharmacological investigation on steroids.

Dr. M. Damodaran (*Madras*): Manufacture of sorbose.

Prof. M. N. Saha (*Calcutta*): Manufacture of vacuum pumps and refrigeration machinery.

Prof. G. R. Paranjpe (*Bombay*): Manufacture of photographic materials in India.

Dr. D. M. Bose (*Calcutta*): Setting up a powerful ultrasonic generator.

Dr. P. K. Kichlu (*Lahore*): Manufacture of X-ray tubes and kenotrons.

Dr. P. C. Mahanti (*Calcutta*): Design of moving iron ammeters and voltmeters.

Dr. S. R. Majumdar (*Calcutta*): Study of polar crystals dissolved in glass systems.

Mr. K. R. Ray (*Calcutta*): Development of air-driven ultracentrifuge for physical, chemical and biological work.

Dr. Mata Prasad (*Bombay*): Manufacture of gelatine.

Central Glass and Silicate Research Institute (*Calcutta*): Production of high temperature refractories used in the glass industry.

Central Glass and Silicate Research Institute (*Calcutta*): Manufacture of optical glass in India.

Dr. G. Gopala Rao (*Guntur*): Manufacture of ceramic glazes and colours.

Sir J. C. Ghosh (*Bangalore*): Rubber-lined equipment for chemical industries.

Dr. B. C. Guha and Dr. B. N. Ghosh (*Calcutta*): Fermentative production of butanol, acetone, solvents generally and acids from molasses.

Mr. M. Sreenivasaya (*Bangalore*): National Collection of Type Cultures.

Mr. M. Sreenivasaya (*Bangalore*): Production of industrial enzymes.

Sir J. C. Ghosh (*Bangalore*): Manufacture of synthetic Methanol*.

Sir J. C. Ghosh (*Bangalore*): Purification of natural graphite ores and preparation of graphite lubricants.

Bengal Potteries Ltd. (*Calcutta*): Manufacture of refractory pots.

Dr. D. Swarup (*Benares*): Survey of research problems on electro-chemical industries.

* The Council sanctioned \$6,000 towards part of the expenses of the pilot plant required for this work. The balance of the cost would be met from the funds of the *Indian Institute of Science, Bangalore*.

- Messrs. Tata Iron and Steel Co., Ltd. (*Jamshedpur*): Manufacture of permanent magnet steel.
- Sir J. C. Ghosh (*Bangalore*): Pilot plant experiments on the manufacture of metallic sodium and magnesium.
- Dr. D. Swarup (*Benares*): Preparation and testing of aluminium-titanium alloys.
- Dr. G. R. Toshniwal (*Allahabad*): Manufacture of cheap radio sets.
- Prof. S. K. Mitra (*Calcutta*): Ionospheric investigations.
- Radio Research Committee and the Indian Meteorological Department: Atmospheric research at Bangalore, Poona, Delhi, Dacca and Vizagapatam.
- Prof. M. N. Saha (*Calcutta*): Theoretical investigations on upper atmosphere.
- Dr. B. C. Guha and Dr. B. N. Ghosh (*Calcutta*): Low temperature carbonization of coal.
- Dr. J. K. Chowdhury (*Dacca*): De-sulphurizing of coal.
- Dr. C. Forrester (*Dhanbad*): Washability of Indian coals.
- Dr. W. M. Vaidya (*Delhi*): Spectroscopy of fuels and their combustion.
- Dr. M. Qureshi (*Hyderabad, Dn.*): Briquetting of coals.
- Dr. B. B. Dey (*Madras*): Manufacture of direct cotton colours.
- Dr. K. Venkataraman (*Bombay*): Preparation of vat dyes.
- Dr. K. Venkataraman (*Bombay*): Synthetic dyes and modified shades from Cutch.
- Dr. K. Venkataraman (*Bombay*): The constitution of commercial dyes.
- Dr. R. D. Desai and Mr. P. N. Joshi (*Bombay*): Manufacture of sulphur black from benzene and naphthalene.
- Dr. P. C. Guha (*Bangalore*): Preparation of aromatic chemicals.
- Dr. B. K. Malaviya (*Lucknow*): Essential oils from bitter oranges.
- Dr. S. A. Saletore (*Nagpur*): Essential oils of the C.P. and Berar.
- Dr. Nazir Ahmad (*Bombay*): Survey of cellulose-bearing materials in India.
- Dr. C. S. Patel (*Baroda*): Preparation of alkali and water soluble ethyl cellulose.
- Sir J. C. Ghosh (*Bangalore*): Preparation of butadiene by the interaction of acetylene and ethylene.
- Sir J. C. Ghosh (*Bangalore*): Manufacture of hydrogen peroxide.
- Dr. P. B. Sirkar (*Calcutta*): Extraction of rare earths and thorium and phosphoric acid from monazite sands.
- Dr. V. Subrahmaniyan (*Bangalore*): Reclamation and utilization of industrial wastes with special reference to textile trade wastes.
- Dr. V. Subrahmaniyan (*Bangalore*): Vegetable rennet.
- Prof. M. N. Saha (*Calcutta*): Measurement of geologic time in India.
- Dr. R. C. Ray (*Patna*): Utilization of waste mica in Bihar.
- Mysore Iron and Steel Works (*Bhadravati*): Manufacture of resistance alloys.
- Dr. S. Siddiqui (*Delhi*): *Serpentina* alkaloids, *Kurchi* barks, industrial uses of *Bhil* an resins, etc.
- Dr. S. Siddiqui (*Delhi*): Investigation on neem oil with reference to its active constituents.
- Dr. S. Siddiqui (*Delhi*): Investigation of anti-malarial drugs.
- Dr. S. Siddiqui (*Delhi*): Investigation on pyrethrum and pyrethrum substitutes.
- Dr. Karimullah and Dr. Lal C. Verman (*Delhi*): Manufacture of polyhydric alcohols.
- Sir S. S. Bhatnagar, Dr. Lal C. Verman and Dr. Karimullah (*Delhi*): Plastics in general.
- Sir S. S. Bhatnagar and Dr. Lal C. Verman (*Delhi*): Synthetic wool from groundnut cakes.
- Dr. Lal C. Verman (*Delhi*): Carbon electrodes for arc purposes.
- Dr. Lal C. Verman (*Delhi*): Portable producer gas test plant.
- Dr. S. Siddiqui (*Delhi*): Semi-synthetic tanning materials.
- Dr. S. Siddiqui (*Delhi*): Ebonite substitutes and allied products.
- Sir S. S. Bhatnagar and Dr. Karimullah (*Delhi*): Industrial utilization of resins obtained from latices of *Euphorbiaceæ*.
- Sir S. S. Bhatnagar and Dr. Karimullah (*Delhi*): Extraction of rubber from *Cryptostegia grandiflora*.
- Prof. S. K. Mitra (*Calcutta*): Manufacture of radio valves in India.
- Dr. Mata Prasad (*Bombay*): Manufacture of beryllium and its alloys.
- Messrs. Tata Iron and Steel Co., Ltd. (*Jamshedpur*): Research schemes on coal blending and coking; cataloguing of literature on metallurgical industry.
- Dr. M. Damodaran (*Madras*): Protein and proteases with special reference to their industrial applications.

(Continued on page 19)



CAPTAIN COOK GRAVING DOCK, SYDNEY*

By MAURICE W. MEHAFFEY

(Australian Department of the Interior)

AUSTRALIA'S greatest single engineering achievement is the Captain Cook Graving Dock at Pott's Point, Sydney. The dock has already been used by the Royal Navy.

This dock can accommodate any ship afloat with an appreciable margin and will permit the Royal Navy to operate freely in the South-west Pacific, and so, after the defeat of Japan, in any part of the world.

To operate on the global plane, the Royal Navy requires global docking and repair facilities. It was considered in 1939 that facilities existing in Durban, Singapore and British Columbia were inadequate to serve the requirements of a fleet operating in the Pacific.

The Australian Government decided that it was necessary for the defence of Australia and the Empire, to provide full facilities in Australia for the docking and repair of the largest capital ships. Sir Leopold Savile of the English firm of consulting engineers *Sir Alexander Gibb and Partners*, was commissioned to examine and report on the most suitable site.

He recommended the present site in Sydney Harbour, between Garden Island and Pott's Point.

Sir Alexander Gibb and Partners subsequently designed and supplied plans and specifications and assisted in the supervision

of the construction work.

The location selected was suitable strategically, adjacent to an existing R.A.N. base at Garden Island and protected by already established fixed defences. It was situated in a first-class harbour, easy of access, with ample anchorage and a navigable channel of adequate width and depth readily available, and adjacent to the highly developed industries of Sydney and near the steel centres of Newcastle and Port Kembla.

Sound rock was available for foundations at a reasonable depth.

General Layout

An area of some 30 acres has been reclaimed to provide wharves, workshops and services.

The dock runs roughly north by west, with entrance facing north, approximately half-way between Pott's Point and Garden Island. From the entrance, the walls are returned at right angles to the central line, to meet a wharf on each side, running north approximately parallel to the dock.

The east wharf, 259' east of the dock centre line, is a reinforced concrete counter-fort wall structure, backfilled, 360' long. This may be later extended to link up with the cruiser wharf at Garden Island.

* Abridged from the article "Details of the Captain Cook Graving Dock, Sydney."

The west wharf, approximately 149' west of the dock centre line, is a reinforced concrete pile and deck structure, which runs north for 486' to connect to the roundhead of the fitting out wharf.

These two wharves form an entrance basin 400' wide.

The fitting out wharf of heavy reinforced concrete construction, lies to the west of the dock, running north-east by north on the prolongation of the line of the existing wharves on the east side of Woolloomooloo Bay for a distance of 860'.

The dock is served by two electric travelling cranes, each of 50 tons capacity at 110' radius, one on each side of the dock. The dockyard area generally is served by two Diesel locomotive cranes of 5 tons capacity travelling on $3\frac{1}{2}$ miles of 4'-8 $\frac{1}{2}$ " gauge railway track, with two mobile cranes of similar capacity.

The fitting out wharf carries a 40-ton electric travelling and a fixed crane of 250 tons capacity at 118' radius.

The main workshops are located on reclamation to the east of the dock, and two smaller workshops behind the fitting out wharf.

Graving Dock

The dock is constructed in mass concrete founded throughout on rock, and was built in the dry inside a coffer-dam. It measures 1,177' from the cope at the entrance to the cope at the head of the dock, with a width at entrance of 147'-7 $\frac{1}{2}$ " and a depth over the sill of 40'-6" below datum, which is approximately L.W.O.S.T. The level of the dock cope and the reclaimed area generally is 10' above datum.

The area between the walls and the banks of the coffer-dam has been reclaimed by backfilling.

The dock walls are of gravity section, generally 41'-6" wide at the base, stepped into 13'-7" at the top. Four continuous altars are provided at intervals up the wall, in addition to a bilge altar and steps at the base.

Within the walls, two subways run right round the dock. The upper carries fire, fresh water and compressed air mains, and cables for operation of valves and for supply of electrical services. Branches are taken up through the walls at intervals to service connections at the cope and to installations in the dockyard.

The lower subway carries a 21" dia. salt water main for supply to ships in dock. Branches are taken through the walls to outlets just above bilge altar level, from which special flexible bronze hoses are provided for connection to the ship.

Direct access to these subways from the surface is provided by three shafts on each side of the dock, which are fitted with armour plate covers.

A cross subway passes under the floor of the dock below the entrance sill, connecting the subways on each side and providing a route for electric cables and service mains.

Three grooves, formed in granite blocks, have been provided in the dock for the floating caisson gates, an outer or emergency groove, and an inner or main groove, at the entrance and an intermediate groove about one-third of the length from the entrance.

The clear length available with a caisson in the emergency groove is 1,134'.

The intermediate groove enables the dock to be divided into two sections, the inner one of 700' and the outer of 395' clear lengths. The arrangement of valves for filling and emptying is such that each section can be used independently of the other. All grooves have inner and outer faces so that water may, if necessary, be impounded within the dock to a level above tide level.

The floor has a level strip 20' wide along the centre, and slopes each side from this to the dock drainage channels, at a fall of 6" in 49'-6".

At the entrance a sill is formed 4'-6" above floor level to carry the main and emergency caisson grooves. This sill is level with a drain on the inner edge to carry any leakage water to the side drains. Another sill, raised 1'-6" above the floor, carries the intermediate caisson groove.

The filling of the dock is carried out by means of two filling culverts, one on each side of the dock. These lead from the return walls down behind the dock walls proper for some distance and then connect up with culverts formed in the base of the walls.

Each culvert discharges into the dock through two sumps in the edge of the floor, one just inside the main entrance sill and one behind the intermediate sill.

The same sumps and the portions of culverts in the walls are used for dewatering. As, however, the pumping equipment is all located on the eastern side of the dock,

the sumps on the western side of the floor are connected to those on the eastern side by means of 4' dia. culverts cast in the floor.

The two floating caissons were designed by Messrs. Vickers Armstrong of Barrow-in-Furness. They are 151' long by 37' wide and 52' deep, with a displacement of 3,655 tons at light draft of 33'-6". They are of all-welded steel construction, bolts or rivets being used only for attachment of armour plating. The sides are protected above water level with 1½" armour plate and a 4" armour plate deck is provided. The top deck is finished off with wood-block paving.

The stem and stern are built with a slope of eight to one, as are the grooves in the walls, so that when floating light, a caisson has adequate clearance for handling into the grooves. When sunk in place, there is about 10" clearance at each end, and tapered timber blocks are used to ensure accurate centering.

Each caisson has a 16' diameter cylindrical water ballast tank running fore and aft, divided into three compartments to adjust trim and tidal chambers on each side above normal water level, separated by a longitudinal bulkhead. When the caisson is sunk, water is first admitted to the ballast tanks. This brings the inlets to the tidal chambers below external water level, the inlet valves are opened and the chambers flooded. The caisson then continues to sink until the tidal chamber valves are closed.

When raising the caisson, the water in the ballast tanks is blown out by compressed air, while the tidal chamber valves are left open to allow the water out.

Pump-house

All the pumping equipment for the dock, except the small subway drainage pump previously mentioned, is concentrated in an underground pump-house located in the angle formed by the east dock wall and the east return wall. This pump-house is a reinforced concrete structure, 140' long by 40' wide, built mostly in rock excavation, with special protection against bombing.

The main pumps are three in number, of the horizontal spindle centrifugal type, with 60" dia. suction and 54" dia. delivery, driven at 272.7 r.p.m. by synchronous motors of 1,000 K.v.a. operating on 5,000 volts.

The pumps draw from the main suction chambers located below the pump-house floor and discharge by way of reinforced concrete culverts through 6' dia. gate valves

in the east return wall. In addition to a main discharge valve in the wall, each pump has a special automatic rapid-closing valve on the discharge side to avoid excessive speed in reverse of the pump and motor when shut off, as the pumps are some 40' below low water level. Another automatic self-closing valve is fitted to the suction side of each pump.

To impound water in the dock above tide level, the delivery of one main pump can be by-passed into the east filling culvert, water being supplied to the main suction chamber through a special 6' dia. valve and culvert in the east return wall.

The three pumps are capable of dewatering the dock in 4 hours at a rate of over 4,500,000 g.p.h. per pump.

Special pumps are provided to deal with all dock drainage and seepage water. Also in the pump-house are two fire pumps capable of delivering 1,825 g.p.m. against a head of 270' to the fire mains round the dock, and three circulating pumps supplying the 21" dia. salt water main in the lower subway.

The main culvert valves, four of which are of 9' dia. and 9 of 6' dia., are of the double-faced wedge type and are operated by electric motor through worm and wheel gearing. There is also emergency hand-operating gear.

All pumps and main valves are operated by remote control from a control desk in the operating floor of the pump-house, and the system is electrically interlocked to ensure correct sequence of operations. Visual indication of operations is given by lights on a mimic diagram in front of the control panel.

Power-house

During normal operation, electric power for the area will be drawn from the Sydney County Council's supply, via two 33,000 to 5,000-volt substations, each of 5,000 k.v.a. capacity, but for emergency operation, an independent power-house has been provided. This is a reinforced concrete structure, built mainly in rock excavation in a cliff face at the south-west corner of the area and covered to give protection against aerial attack.

In addition to the stand-by electrical equipment, which consists of three 1,250 k.v.a. Diesel-driven alternators generating at 5,000 volts, the power-house also contains the installation for supply of compressed

air to the dockyard, comprising two compressors of 1,200 cu. ft. per minute, and one of 500 cu.ft. per minute of free air, a 500-k.w. motor generator set for ships' supply and a 160 k.w. Austin constant current motor generator for capstan operation.

Workshops

The main workshops, 450' long by 140' wide, are of steel frame construction with reinforced concrete blast walls faced with brick. The three rows of main columns are carried on 18" x 18" reinforced concrete piles driven through the reclaimed ground to a depth of 15' to 20' into the old sea bed, and the concrete machine bases are on timber piles similarly driven.

Each of the two bays carries two overhead travelling cranes, one of 10 tons and one of 60 tons capacity.

Construction of Cofferdam

Although a number of bores had been put down over the area during the investigation of proposed sites, it was necessary to make a much more exhaustive survey of the foundation conditions.

More than 200 pipe and wash bores were put down along the proposed line of the coffer-dam embankments and over the area generally and from their results a rock contour plan was prepared. In addition, 22 three-inch cores were taken with a diamond drill plant to prove the quality of the rock, particularly over the area proposed for the dock structure.

Other preliminary work involved the re-location of water, telephone and electric power mains to Garden Island, which at that time were all laid on the sea bed across the side.

As the area of land available at Potts' Point foreshore was very limited, it was first necessary to reclaim about 3½ acres to provide a working area.

Construction of the coffer-dam was commenced at the beginning of 1941. This was made up of two embankments, the north-west running from the end of Potts' Point and curving round eastwards to meet Garden Island, and the south-east, starting from Potts' Point, about 700' further south and curving round to north to meet the southern tip of the island. These consisted essentially of sandstone ballast banks retaining a clay core in the centre of which a steel sheet piling wall was driven, and enclosed an area of approximately 33 acres.

Dewatering

As soon as the coffer-dam was completed, in February 1942, dewatering was commenced by the use of pumps mounted on barges and discharging over the embankments through a flexible-jointed floating pipe-line. Sumps had previously been dredged to provide for drainage of the areas as dewatering was completed.

The water level was lowered in 5-foot stages, every 5 days, the pumping generally occupying 2 to 2½ days, and the balance of the period being allowed for drainage and consolidation of the embankments.

Excavation

As soon as the exposed sea bed was hard enough to carry plant, an access road was constructed down from the foreshore on the western side and excavation begun. Caterpillar track, steam and Diesel-powered shovels were used, as many as eleven being in operation at one time, ranging from 5/8 cu. yd. to 2½ cu. yd. capacity. Disposal was by means of motor trucks and all suitable material was placed on the inner sides of the coffer-dam embankments to form part of the permanent backfilling.

The rock formation rose to form a ridge linking Potts' Point and Garden Island, falling away generally to the north-east and south-west. On the ridge, the quality of rock proved so satisfactory that, in place of the 8' originally contemplated, a minimum depth of 5' of concrete for the floor was decided on, over the area from the main sill to the intermediate sill. South of this, however, the rock was not so good, and it was necessary to carry the excavation much deeper.

The total quantities of excavation carried out in the dry over the area of the dock and entrance basin amounted to some 120,000 cu. yds. of rock and 260,000 cu. yds. of other material.

Concrete

The greater part of the concrete poured was supplied from a central mixing plant established on the foreshore of Potts' Point opposite the southern end of the dock.

An additional small plant with a single 1 cu. yd. mixer was erected on the reclamation south of Garden Island to supply concrete for the east wharf and the pump-house.

The general scheme for concreting the dock called for the central mixing plant to deliver concrete to the bottom of the

excavation by 1 cu. yd. skips lowered down a ramp behind the southern end of the dock. There they were hauled by narrow-gauge Diesel locomotives to overhead telfer transporters which lifted and deposited them. The transporter ran on rails laid on the outer units of the dock floor, which had previously been poured by the aid of mobile cranes.

The best day's output when this plant was in full operation was some 1,900 yards during three shifts.

The dock floor was concreted in blocks, generally 22'-6" long by 20' to 24'-9" wide, poured alternately with an interval of six weeks between adjacent blocks to minimize contraction cracking. Owing to the necessity for speed, it was not possible to adhere to this sequence, particularly with the outer blocks carrying the transporters. In such cases, provision was made for grouting the joints between units.

The dock walls were built in units 40' long with five-foot gaps between the 40' lengths, these gaps being concreted 8 to 12 weeks after the equivalent pour in adjacent blocks. This period allowed most of the initial shrinkage of the concrete in the 40' blocks to take place, while still allowing for some further shrinkage to provide for subsequent re-expansion.

To prevent leakage into the subways, watertight seals of bent copper strip were set in the concrete across construction joints completely surrounding the subways.

To facilitate the lengthening of the dock, should it ever become necessary, the east and west walls are prolonged past their intersection with the south wall. The south wall itself is founded not on rock but on top of the extreme end units of the floor.

Except for the reinforced concrete piles, which were made with normal portland cement, low heat cement was used for all parts of the work. The 28 days' test results with this cement were generally very satisfactory, but, particularly during cold weather, the concrete was rather slow to harden in the early stages. With regard to the low heat qualities, temperature records taken during the summer in large pours at the bases of the walls indicated a maximum temperature rise of 35° to 40° F.

The total quantity of concrete placed in the dock and adjacent structures amounted to some 310,000 cubic yards.

Caissons

The two caissons were built within the coffer-dam alongside the east wharf, thus overcoming the difficulties of launching craft of such deep draft by making it merely a matter of flooding the dock and entrance basin.

In September 1944, as the construction of the caisson had reached a stage sufficiently advanced for them to be floated safely, the main culvert valves had been installed and the pumping machinery was well in hand, and all essential work below tide level completed, the dock was flooded. The water was admitted through the two 21" dia. pipes previously mentioned, and led by two pipe-lines across the entrance basin excavation to discharge well inside the dock entrance, to avoid washing material on the floor. These pipe-lines were carried on floats, and sections uncoupled as the water level rose, until discharge was through the 21" dia. pipes only.

When flooding was completed, No. 1 caisson, which although incomplete was structurally capable of acting as a gate was placed in the emergency groove and the dock pumped out by means of the drainage pumps, the main pumps not being available.

Removal of Embankment

After the caisson and the drainage pumps had proved themselves capable of keeping the dock dry, work was started on removal of the northern section of the coffer-dam embankment, which extended across the entrance basin and prevented the entry of any ship.

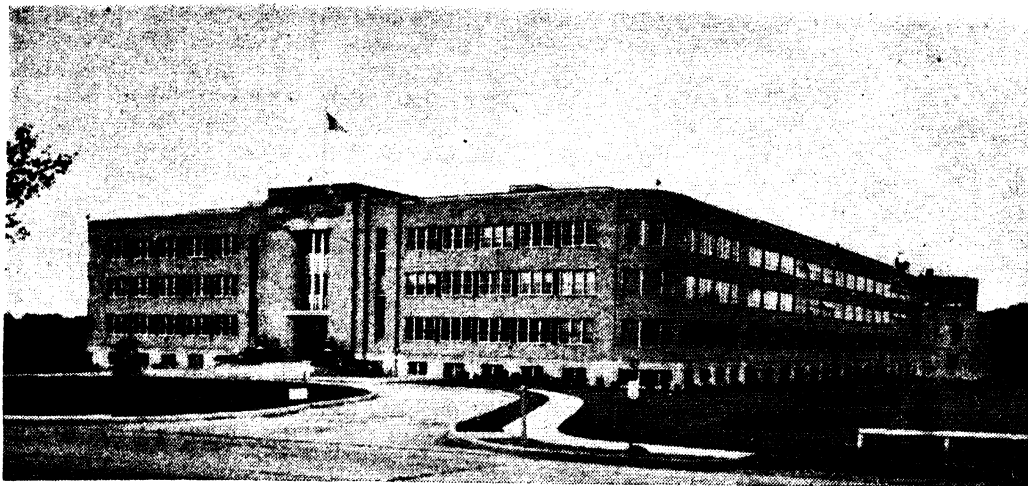
The sheet piling wall and the old timber piles of the temporary staging were withdrawn without much difficulty with the aid of special pile extracting gear and a 150-ton floating crane.

The removal of the ballast and clay forming the embankment was carried out by two 4 cu. yd. draglines working from the top of the bank to about 35' below low water, with a ladder bucket dredge removing the balance to the final dredged level of 43' below datum.

Fitting Out Wharf

The construction of the fitting out wharf was carried out concurrently with that of the dock, but as a separate unit.

Although a number of component parts of the project as a whole are not yet complete, the dock itself is now in use.



AGRICULTURE AND INDUSTRY CO-OPERATE UNDER U.S. DEPARTMENT OF AGRICULTURE *

THE U.S. Department of Agriculture often provides a meeting ground between industry and agriculture. Research and experimentation by scientists in its *Bureau of Agriculture and Industrial Chemistry* result in precise knowledge of value in both fields.

Penicillin, the wonder drug, is a case in point. This highly important drug was discovered and produced in small quantities by British scientists. Large-scale production, impossible at the time of the Japanese attack on Pearl Harbour, is now under way, and the valuable mold, once grown in milk bottles, is being grown in huge tanks with a capacity of 2,500 gallons (9,500 litres).

Much of the credit for this fortunate situation must go to the researchers of the Agriculture Department. Because the Department's Northern Research Laboratory in Peoria, Illinois, has the world's largest collection of molds, quantity production of penicillin was undertaken there with the approval and co-operation of the British scientists who had first produced it.

Scientists at the Peoria station, after many tests, tried feeding the mold on a diet made from corn starch. This resulted in an increase of 100 times the yield from the culture mold. Further experiments with other agricultural products showed that the mold did well when fed on lactose sugar which was derived from cow's milk.

Assured of the correctness of their findings, officials of the Department's Agricultural and Chemistry Bureau summoned interested commercial chemical producers, explained the results and offered them complete information for use in commercial scale production.

To-day 15 or more companies are using the Department's formulas in producing penicillin. Rapid rise in production has cut the price from \$20 to \$3.25 per 100,000 units. By the end of 1944, officials estimate, enough penicillin will be produced to treat 250,000 serious cases per month. Practically all such production, however, has been assigned for military use. †

In order to increase industrial outlets for the nation's farm products, in 1938 the United States Congress authorized the establishment of four large regional laboratories under the Department of Agriculture.

Test-tube experimentation was enlarged to the pilot-plant stage by construction of the laboratories. By the use of these plants, within the research stations, a semi-commercial production could be achieved, a situation previously impossible under the limited facilities possessed by agriculturists and State college research institutions.

When scientists from the Bureau of Agricultural and Industrial Chemistry

* Through the courtesy of the *United States Office of War Information*.

† Penicillin has since been released for civilian use.

accomplish significant results, officials call a conference with commercial representatives interested in quantity production. All

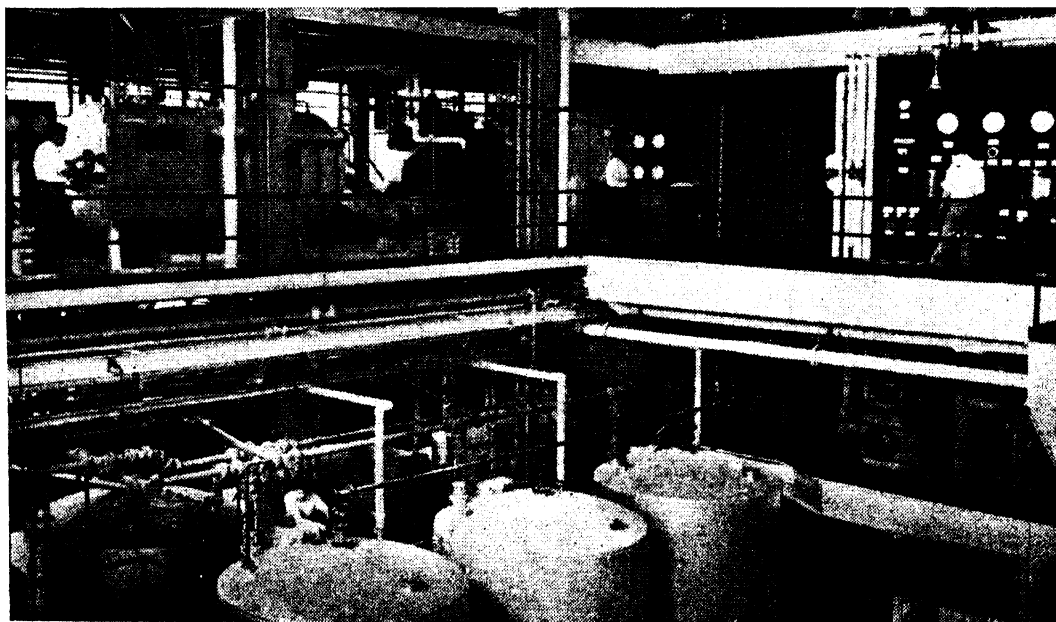


A battery of two-quart (about two litres) milk bottles being used for penicillin production in the Peoria Laboratory.

information showing how agricultural products may be used in such chemical manufacture is made available to these firms, and results are shown on both test-tube and pilot-plant scale. The next steps of commercial production, distribution and sale to the consumer are, of course, up to the industry.

Approximately two years ago the scientific research of the Department of Agriculture was consolidated into an agency known as the Agricultural Research Administration. This includes eight bureaus and agencies, the Bureau of Agricultural and Industrial Chemistry ; the Bureau of Animal Industry ; the Bureau of Dairy Industry ; the Bureau of Entomology and Plant Quarantine ; the Office of Experiment Stations ; the Bureau of Human Nutrition and Home Economics ; the Bureau of Plant Industry, Soils and Agricultural Engineering ; and the Beltsville Research Centre.

Dr. Orville E. May, co-ordinator of chemical and chemical engineering research programmes in the Agricultural Research Administration since its start in 1942, was recently appointed chief of the Agricultural and Industrial Chemistry Bureau by Secretary of Agriculture Claude R. Wickard. Dr. May succeeded Dr. W. W. Skinner,



An alcohol pilot plant in the Northern Regional Research Laboratory.

who retired after 40 years of service with the Department.

The 42-year-old Dr. May, deeply interested in the expansion of industrial use of farm products, has been a long-time exponent of Government-conducted research along this line. However, he realizes that such research, to be really valuable, must be made available to industry. "The usual procedure," he says, "has been to publish research results in a technical journal or Government bulletin and assume that the job is done."

**Makes Agricultural Information
Available to Industry**

Under Dr. May's direction, the regional research laboratories have experimented, for the past two years, with the industrial conference idea, "as a rapid and efficient means for the transmittal of technical information to industries in a position to make use of it."

Some strategic materials have been put into commercial production as a result of the work of the research laboratories now on a 100-per-cent. war basis. According to Dr. May, "a number of such conferences have been held dealing with such subjects as production of butylene glycol by fermentation of carbohydrate materials, conversion of butylene glycol butadiene, production of

industrial alcohol from wheat and recovery of feed by-products from such production,



Dr. Orville E. May, Chief of the Bureau of Agricultural and Industrial Chemistry of the U.S. Department of Agriculture.



Part of the great mold collection in the Fermentation Division of the Northern Regional Research Laboratory in Peoria, Illinois.

and production of rubberlike materials from vegetable oils."

Under the pressure of war needs, Agriculture Department researchers have concentrated much of their effort on developing needed materials from waste products or ordinarily useless farm materials.

Farm wastes are used by the Peoria men in producing a new type of lignin plastic which can be used as a replacement for metal in many ways. Made from cornstalks, wheat straw, flax shives and other fibrous materials, it uses only half the phenol formaldehyde resin—a critical war material—commonly required in the manufacture of this type of plastic.

The new plastic, with physical properties similar to the original product, was suggested for a secret military use, tested and found practicable.

Agricultural Products for War Industries

More than 1,000 persons, over half of whom are highly trained chemists, physicists, engineers and other scientists, are now employed in these centres. Research is under way on almost 150 projects directly connected with the industrial use of agricultural products in the war effort. These

include work on rubber, industrial alcohol, smokeless powder, industrial proteins, essential drying oils, rotproofing of sandbag material, rubberless cotton fire hose, preservation of vegetables by dehydration and freezing, conservation of leather and many other important projects.

The Southern Research Laboratory at New Orleans, Louisiana, has contributed the development of a substitute for cotton linters, which are used extensively in the manufacture of smokeless powder. Linters are short fibres adhering to cottonseed after the first ginning. They are removed and nitrated for smokeless powder production.

A machine was designed that would cut ordinary cotton into tiny pieces similar to linters in a short time and in enormous quantities. The first machine, a small one, proved successful and designs were drawn up for a much larger machine, which has already been constructed and is now in operation.

Dr. Skinner, retired chief of the Bureau of Agricultural and Industrial Chemistry, has declared that one "reason for the success that has come to these laboratories is the fact that they have received wholehearted co-operation from industry and Governmental institutions."

INDIAN INDUSTRIAL DELEGATION TO AUSTRALIA AND NEW ZEALAND

REFERRING to the work of the Delegation which toured Australia in February-March 1945, Sir Datar Singh, leader of the Delegation, writes:

"The Delegation toured all the six States and Canberra, and paid visits to important factories, farms including livestock, sheep and poultry, irrigated and unirrigated tracts, etc. During the tour, the Delegation met twenty Chambers of Commerce and roughly travelled 6,000 miles by air and 3,000 miles by cars within Australia. The Delegation availed itself of opportunities of meeting and discussing matters with the Ministers and heads of Departments of Industries and Agriculture, and the Hon'ble Prime Minister and his Cabinet at Canberra. The delegates can claim to have seen a good bit of Australia, its industries and agriculture, and to have explored the possibilities for increased trade between India and Australia on reciprocal basis.

"The Delegation was satisfied with the

straightforward and frank talk of officials and non-officials at all places and was well received by all people including the Press. The State looked after the transport, board and lodging and gave all help and assistance to the delegates to make the tour successful and comfortable. The Hon'ble Prime Minister and his Cabinet gave a lunch at Canberra and speeches were exchanged.

"The Delegation was amazed at the industrial development in the country, as practically little had been done before the war. Perfection has been achieved in such a short time, and this can be attributed to the supply of capital machinery and technical assistance from outside. Not only was such help instrumental in bringing the imported machinery into production but it also stimulated the fabrication of machinery within the country itself. Australia is in a position to-day to supply several items of heavy and light machinery to other countries."

CHROMITE *

By B. RAMA RAO

(Mysore Geological Department)

Introduction

CHROMITE—also styled variously as chrome ore, chrome iron ore, chromic iron ore, etc.—is the principal ore of the metal chromium which, as an element, was first isolated in 1797, by Vaquelin and which derives its name from the Greek word, *chroma* meaning colour. Though the Sanskrit equivalent of chromite has been given as *Varnitha* in the *Great English-Indian Dictionary* (under compilation and editing by Dr. Raghu Vira, Lahore), it is not likely that the mineral had been recognized or used by the ancient people in India. It is one of the few minerals which finds a varied use in many of the modern industries of both normal and war-time pursuits. Its distribution in the world is rather confined to a few countries amongst which India is one which has been blessed with a fair share. Under normal conditions, excepting the Soviet Union which has an appreciable output of chrome ore, most of the other consuming countries have to depend, for their requirements of this mineral, upon the imports from sources of supply from far-off and remote areas. Consequently, chromite has ranked in the past few years high in the list of strategic minerals of all major countries involved in the present war. Even in normal times, chromite will have a good market, a major portion of the mineral produced being required for the production of ferro-chrome and stainless steel, refractories, chemicals for tanning industries, etc.

Composition and Distinguishing Characters

The chrome ore or *chromite* ($\text{FeO Cr}_2\text{O}_3$) may be considered as a chromate of iron conforming theoretically to the composition, 68 per cent. of chromic sesquioxide (Cr_2O_3) and 32 per cent. iron protoxide (FeO). As found in nature, however, the ore is never absolutely pure, its chromium being replaced to a variable extent with ferric iron and alumina; and its ferrous iron, by magnesium; and consequently it seldom contains more than 50 to 52 per cent. of chromic oxide (Cr_2O_3).

Chromite forms octohedral crystals in the isometric system, but generally it is found massive with a granular to compact texture. It varies in colour from dark brown to jet black and leaves a brown streak. The mineral has a metallic to sub-metallic lustre and is feebly magnetic. It is fairly hard ($H=5.5$ on Moh's scale), scratchable with difficulty, with a knife. Its specific gravity ranges from 4 to 4.6 and its melting point $1,545$ to $1,730^\circ \text{C}$. according to its composition.

In addition to its characteristic physical properties noted above, chromite can be identified easily by simple blow-pipe tests. The mineral colours the borax bead, reddish yellow when hot and yellowish green when cold (reaction for iron) in the oxidising flame; and an emerald green (reaction for chromium) in the reducing flame. The microcosmic salt bead, with chromite, both in the oxidising and reducing flame, is dirty green while hot and clear green when cold. Fused with sodium carbonate, chromite gives an opaque yellow bead.

The mineral is not acted upon by acids, but can be decomposed by fusion with potassium or sodium bisulphate.

Mode of Occurrence and Origin

Chromite is usually found in the ultrabasic rocks (peridotites, pyroxenites and amphibolites) and their derivatives—the serpentine, talc, and talc-chloritic schists. It is generally associated with magnesite and, in some places, with platinum, titaniferous magnetite, nickel and cobalt minerals, asbestos, etc.

In the primary deposits chromite may occur either as disseminated grains scattered throughout the parent rock, or as segregated sporadic patches; and also as veins, lenses and tabular ore bodies. As a primary deposit chromite ore bodies may result (1) from early differentiation and segregation prior to the consolidation of the ultrabasic rocks, or (2) at a later stage when the consolidated magma undergoes hydro-thermal alteration forming intrusive veins and injections into the parent rock.

There are instances where the primary deposits of disseminated chromite have

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor, 20, Pusa Road, New Delhi.

been converted into workable secondary deposits by residual concentration—the insoluble chromite being left at the surface after removal of the enclosing rock. Alluvial deposits formed by the transportation of residual chromite, by water, are also occasionally met with.

Distribution in India

Chromite is found to occur in India in (1) Baluchistan, (2) Mysore, (3) Bihar and Orissa, (4) Ratnagiri Coast in the Bombay Presidency, (5) Salem district in Madras, and also in a few other places of minor importance.

Baluchistan.—Though chromite was first made known to occur in Baluchistan in 1879, it was only in 1901 that the chromite deposits were definitely located. Chromite occurs in this area near Khanozai in the hills above the Upper Pishin valley and also near Hindubagh in the hills above the Upper Zhob valley. A comprehensive study of the deposits of these two areas by Fermor, in 1916, shows that the chromite occurs in serpentine derived from the alteration of enstatite-peridotite (saxonite) of the late Cretaceous or early Tertiary age. The ores produced in these two areas are of high grade and are believed to have resulted as a product of magmatic segregation from the ultrabasic, saxonitic magma.

The deposits occur as veins and irregular masses—very variable in shape and size—one of the biggest reefs located, about 2 miles east of Khanozai, measuring about 400' in length and 5' in width. This yields 54 per cent. Cr_2O_3 . Besides Khanozai and Hindubagh areas, chromite is found, as lenticular masses, at Azghar Tangi, a mile east of Jelat Kalai near Fort Sandeman; and as float ore at Saragara, about a mile south of Gadai Khel Kalai. These two areas are of minor importance and the quality of ore from both of them is also poor,—the Azghar Tangi deposit yielding about 37.86 per cent. Cr_2O_3 and Saragara deposit, about 43.62 per cent. Cr_2O_3 .

Production of chromite began in Baluchistan in 1903 with an output of 284 tons of ore. The peak production was in 1937 when 27,209 tons of ore were won. The total production from 1903 to 1938 amounts to 4,20,103 tons.

The Baluchistan high grade chrome ore has approximately the following composition: Cr_2O_3 , 54.5; FeO , 13.0; MgO , 15.5; Al_2O_3 , 11.0; and SiO_2 , 2.5.

The ore mined in the Zhob district is railed to Karachi port, a distance of 600 miles, from where it is exported.

Mysore.—In Mysore, chromite was first discovered in 1899, by H. K. Slater who reported its occurrence as grains in a talcose rock near Harenhalli, Shimoga district. In subsequent years, the mineral was located in the districts of Mysore, Hassan, Kadur and Chitaldrug. In most of these areas chromite usually occurs as small grains in some of the serpentinised ultrabasic rocks (believed to be intrusive in the Dharwar schists) sparingly distributed and of no commercial value; but in some places in the Mysore and the Hassan districts it is found as regular veins, lenses and segregated patches forming workable ore bodies.

In the Mysore district, the chrome ore occurs as veins, lenses and segregated patches in some of the bands of serpentinised ultrabasic rock, exposed between Mysore and Nanjangud, specially to the west of Kadakola; of these the deposits at Sinduvalli (Shinduvalli) are the best and the largest. In this area, which lies about 3 miles to the west of the Kadakola railway station, in the middle of a narrow band of a serpentinised peridotite which runs north and south for a couple of miles, a number of small veins of solid chromite were found, which, when followed underground, bulged out in places to wider lenses. These ore bodies have been worked by underground methods to a depth of more than 400' in some sections, and the mine has so far yielded about 136,000 tons of high grade ore which varies from 48 to 52 per cent. in its chromic oxide content. The workable reefs disappeared at about 480' from the surface in the main shaft and for another 80 to 100' beyond, excepting some very thin streaks, the chromite reef did not re-appear. The ore bodies in this mine consequently seem to be nearing exhaustion and the lessees have been thinking of abandoning the mine.

Further west, at Talur, Uradabur and Dodkatur there are some lenticular patches of chromite containing 40 to 44 per cent. Cr_2O_3 , in the serpentinised ultrabasic rocks. All these in the aggregate may not yield more than 20,000 tons of low grade ore. The Talur deposit, situated about 2 miles west of Sinduvalli, was being mined by the State Geological Department, by underground methods, during the years 1927 to 1932 when some 3,800 tons of ore yielding from

44 to 47 per cent. Cr_2O_3 had been raised. When the mine had reached a depth of about 120' the work was suspended, in 1931, and has not been resumed so far. Some of these areas have yielded till now about 5,250 tons of float ore occurring as pebbles in the soil. Besides these, there are deposits of chrome ore at several other places—Kumbar Koppal, Solepur, Chikkatur, Dodkattur, Uttanhalli and Marsettihalli—many of which yielding less than 30 per cent. Cr_2O_3 . Some of these can be improved considerably in quality by concentration. These are not being mined.

In the Hassan District, in the narrow belt of schists which runs to the west of Nuggehalli, from Jambur to Arsikere, several large ore bodies have been located. This belt of schists, called after the village Nuggehalli, runs N.N.W. and has a total length of about 35 miles with an average width of $\frac{1}{2}$ mile, and consists mainly of dark hornblende schists, amphibolites and other altered ultrabasic rocks. In this zone the chromite ore bodies occur in thick lenses and bands in a talc-serpentine schist (altered form of enstatite-peridotite). Tracing from south to north the deposits in this belt are found to occur at Jambur, Tagadur, Ranganhalli, Aladhalli, Chikkonhalli, Bhaktarahalli, Byrapur, Gobalihalli and Pensamudra. Many of these are of low grade containing less than 42 per cent. Cr_2O_3 . This region is estimated to contain about half a million tons of ore of all grades, in which what may be classed as high grade ore containing more than 47 per cent. Cr_2O_3 , amounts to a little less than 90,000 tons. The deposits are all worked here by open quarries since 1916, and so far the total quantity produced from the different mines in the area amounts to about 300,000 tons including the quantity of ore produced at Byrapur. The Byrapur deposits contain a few thick lenses and veins of high grade ore yielding more than 48 per cent. Cr_2O_3 ; and these had been mined by the *Mysore Chromite Limited*—a private company—during 1918-19, when they had raised about 29,150 tons of ore. Since 1920, this block has been reserved for the Government; and the Geological Department, re-starting the mining operations in 1927, had mined and sold during the 10 years ending with 1937, about 52,000 tons. With a view to conserve this high grade ore for the State's industrial needs, the mining operations were discontinued in 1937, but

has been recently resumed, however, on a much smaller scale.

The nearest railway station to the Byrapur and Bhaktarahalli mines—the principal producers in this zone—is Tiptur on the Bangalore-Poona route.

In the Kadur District, chrome iron ore is found as reefs, lenses and segregated patches in serpentine, derived from amphibolites, near the villages Bande, Banur and Gajekatte in the Tarikere taluk, close to the Sivani railway station. These are all of low grade—not exceeding 30 per cent. Cr_2O_3 —and may yield about 20,000 tons in the aggregate. Some pebble beds and small lenses of low grade ore are also found near Kuppalu, Banenhalli and Chamenhalli in the Kadur taluk.

In the Chitaldrug District low grade chromite occurs near the Kalangavi hill, in sporadic lenses and pockets in the altered ultrabasic rocks. The area is estimated to yield about 25,000 tons of ore. Out of the 12 samples collected and analysed from this area, only one yielded 31.3 per cent. of Cr_2O_3 and all the others below 30 per cent.

In the Shimoga District chromite has been found near Harenhalli, Jhandimatti and Antargange, associated with iron ore; and also some 2 or 3 small patches of ore, in serpentine, to the south of Amblikatte hill in the Shimoga taluk. These are all very small and being of very low grade have no commercial value.

In Mysore, chromite mining began in 1907. From that year to 1915 the production was entirely from the Sinduvalli mine when it mined and exported 12,186 tons; but from 1916 onwards, the mines in the Hassan District took a lead up to 1929 when they exported nearly four times the quantity from the Mysore District—the highest quantity exported being in 1922. Owing to the difficulty in getting shipments due to the present war conditions there has been very little export of chrome ore to foreign countries during the last 4 or 5 years; consequently the production has considerably fallen and there has been very little activity in most of the chrome mines, at present.

Till recently, the ore was being produced in Mysore solely for export and the high grade ores, containing above 48 per cent. of Cr_2O_3 , found a ready sale, while the lower grades, which contained at least 42-44 per cent. Cr_2O_3 had some occasional demands. It has been very difficult to sell the ores

containing less than 40 per cent. Cr_2O_3 . Investigations show that the low grade ores can be considerably improved in quality by gravity concentration. The *Mysore Chromite Limited* have been concentrating some small quantities of low grade ores, which improve in their chromic oxide contents from 38 to 50 per cent. or even higher; but, since the price usually paid for such concentrates is no higher than that of the 48 per cent. reef ore, concentration of low grade ore for export purposes does not seem to turn out advantageous.

Average Analyses.—The following represents the average analyses of some of the Mysore ores :—

Constituents	1	2	3	4
	%	%	%	%
Cr_2O_3	49.73	50.63	51.0	45.69
Al_2O_3	6.22	13.29	7.5	12.55
FeO ..	19.54	18.51	22.5	20.26
MgO	12.75	14.65	12.0	11.70
SiO_2	5.81	1.56	4.5	4.45

1. Byrapur ore. Analysis by Chemist, Mysore Geological Department. 2. Sinduvalli ore. Analysis by *Burn & Co., Ltd.*, Raniganj. 3. Mysore ore. A. B. Searle's *Refractory Materials* (1924), 171. 4. Low grade ore—Talur. Analysis by Chemist, Mysore Geological Department.

Bihar and Orissa.—Chromite was first discovered in Bihar, in the Singhbhum District, in 1907, by R. Saubolle who, during the course of his prospecting, found a specimen of the ore near the Sura Pass between Chaibasa and Sonna. Fermor subsequently re-examined this area, in 1918, and found that the ore occurs in segregated bands and lenses in the partially altered peridotites—serpentinised dunite and enstatite-saxonite. These altered ultrabasic rocks are exposed as disconnected patches forming lenticular intrusions in the Dharwars, and folded with the shales, slates and other members of that system. They occur as three separate patches near Jojohatu, forming the Roro-Chitung Buru, Kitta Buru, Kimsi Buru and other hills in the Kolhan estate, west of Chaibasa.

Amongst the several chromite deposits in the area those on the Roro-Chitung Buru are the most important, containing ore bodies ranging in grade from 40 to 53 per cent. Cr_2O_3 . The Roro-Chitung Buru forms a narrow hill range, with two peaks, Roro-Buru and Chitung-Buru, and discloses ore bodies near the former. On the northern

slope of this peak, Roro-Buru, chromite is mined in two places. In one of these it occurs as low grade float ore (44 per cent. Cr_2O_3) beneath an overburden of 5 to 15'; and in the other, as a solid band of high grade ore, 1' thick, in a massive bed of serpentine, yielding 53 per cent. of Cr_2O_3 . The ore here is granular and the ore body, due to reverse faulting of the peridotite has been thickened along certain zones. On the south side of the peak, the high grade ore occurs as a compact mass running parallel to the boundary of the country rock—the serpentinised ultrabasic mass—and is quarried from a trench which extends for several furlongs in length with a width of about 40'.

In the Kitta-Buru the chromite beds occur, quite irregularly disposed, beneath an overburden ranging from 10' to 35'. The ore here is of low grade. In Kimsi-Buru, which is to the north of the above two hills, the chromite deposit does not seem to have been explored but the available evidences indicate that the ore body is extensive and of high grade.

In the Jojohatu area, the chromite ore has been divided into four types—(1) *Boulder ore*, which occurs as boulders, often containing 48-52 per cent. Cr_2O_3 , (2) *Reef ore*, which occurs in thin veins, often branching and cemented by serpentine and invariably requires cobbing to bring up the percentage to 48 per cent., (3) *Yellow Reef ore*, which consists of small yellow nodular aggregates of chromite, looking like yellow ochre but better than reef ore and containing 52 per cent. Cr_2O_3 , and (4) *Lateritic ore*, which occurs below the laterite capping and is usually coated with red ochre, the percentage of chromic oxide being only 35-40 per cent.

In Singhbhum, the ore as mined is hand-sorted and concentrated by cobbing, i.e., separating the pieces of ore from adhering pieces of country-rock by means of a small chisel-shaped hammer. When the ore is in very small pieces, it is crushed by means of *Durmut* on flat iron sheets. The powdered ore is then concentrated by winnowing and panning. Recently the *Tata Iron and Steel Co.* have installed in their Kitta-Buru mines a plant for crushing the ore and a hydraulic classifier and a Wilfley Table for concentration.

The nearest railway station to the Singhbhum deposits is Chaibasa, which is 15 miles away, and the ore is transported to

the railhead in bullock carts and trucks. From Chaibasa, it is railed to Calcutta and other places. Excluding the 400 tons of ore extracted in 1909, regular exploitation on a commercial scale began in this region in 1913. Singhbhum produced during the 25 years (1913-38), 91,290 tons of ore—the largest production during the period being 11,397 tons, in 1935. The chief producing company in the area is said to be capable of raising annually from 8,000 to 10,000 tons of chromite of three different grades.

Apart from Singhbhum area, the ore is found at Janoa and Ranjra Kocha in Karaikela, 12 miles from the chromite deposits of Jojohatu. These deposits extend into Orissa and are being worked in Saraikela State in the Eastern States Agency. Chromite also occurs in Baidichauk, about 5 miles from Mandar hill station in the Bhagalpur District and indications of the mineral have also been found in the Hotang Hill, Silli Estate, in the Ranchi District of Bihar.

Bombay.—The occurrence of chromite in the Bombay Presidency, near Kankauli in the Ratnagiri District, on the bank of the river Janauli, and near Vagda in the Savantvadi State, south of the Gad river, was first mentioned in 1910. Subsequent study of the deposits of these two areas shows that chromite occurs in both the areas, as irregular veins and lenses, in serpentine rock associated with the older pre-Cambrian schists and gneisses. Both the places are accessible, through good roads to the ports of Malvan and Devgad. The percentage of Cr_2O_3 in Kankauli deposit ranges from 31.6 to 36.49 and that of Vagda deposit, from 33.4 to 39.0. Mining on a commercial scale is stated to have commenced in 1937 when about 500 tons were produced. It has been estimated that the ore reserves at the two localities would amount to about 67,000 tons.

Madras.—Chromite occurs in thin veins varying from a few inches up to 3' or 4' thick, and also in lumps scattered through magnesite, in the Chalk Hills of the Salem District. These deposits are reported to be unworkable, economically, and might become useful only in case there is any interruption in supply from other usual sources. The quality of the ore is also poor, the two samples which have been analysed showing 35.6 per cent. and 44.5 per cent. Cr_2O_3 . Apart from the Chalk hills deposits, indications of

chromite are reported to have been found at Yedichicolum on the Cauvery, near Trichinopoly; and also near Kumarapalayam some 12 miles south of Sankaridrug and at the northern extremity of the magnesite deposit of Chetti-Chavade Jagir—the latter two, in the Salem District.

Fairly extensive ore bodies consisting of high grade ore yielding 45-50 per cent. Cr_2O_3 are reported to have been found recently in the neighbourhood of Kondapalli (near Bezvada), Krishna (Kistna) District. These are believed to contain about 50,000 tons of ore; however, on these there has been no authentic information published till now. The area seems to need careful prospecting before the actual extent of the ore bodies can be correctly ascertained.

Kashmir.—Mineral survey of Kashmir State has revealed the occurrence of huge masses of chrome-olivine rocks forming a series of hills and mountain masses in Ladakh, which may yield large quantities of chromite. Since they are quite inaccessible to reach except through a bridle path running through a high pass with precipitous hill sides, the area has not been exploited to find a commercial use for the ore.

N.W. Frontier Province.—Small segregated pieces of chromite have been found near Bhunjakaghan valley, Hazara district, N.W. F. Province.

Andaman Islands.—About 100 yards south of the village of Chakrgoan near Port Blair, South Andaman Island, indications of chromite have been found.

Burma.—Chromite is found in several places in Burma, but in none of them the mineral is abundant enough to be worth exploitation.

Mining and Dressing

In the case of narrow veins and lenses, persisting regularly in length for considerable distances, underground methods of mining are commonly followed with advantage; but with the disseminated type of ore bodies and thick lenses irregularly distributed, open quarrying is generally preferred. In a few cases, as at Sinduvalli in Mysore, it may be advantageous to develop the deposits to some depth by open quarrying and then resort to underground methods if the conditions warrant. In all cases it is desirable to study carefully the form and underground extension of the ore bodies both laterally and vertically either by the

geophysical survey methods where practicable or by intensive core drilling, before resorting to any specific method of mining.

In many cases the good quality reef ore as mined will be of sufficient purity to come within the marketable grade and hardly needs any dressing excepting perhaps some hand picking. In the case of disseminated deposits, and low grade ore bodies yielding 40 per cent. or less of Cr_2O_3 due to admixture with other minerals or country rock, the grade can be considerably improved and brought up to 50 per cent. and more by concentration. This is effected by fine grinding of the ore and the elimination of the admixed impurities on shaking screens, concentrating tables, or jigs as best suited to the specific nature of the ore. Where the ore contains an intimate mixture of magnetite and chromite, concentration may be effected by removing the former by magnetic separators.

In America, recently, concentration of alluvial deposits of low grade chromite, yielding about 6 per cent. Cr_2O_3 , has been attempted with success. The plant for this purpose, designed by I. B. Humphrey, is worked by the application of centrifugal force. The concentration plant consists of a preliminary screening and washing unit, a disliming unit, the spiral launder concentrator with accessory pumps, a classifier and a small drag-line. A recovery of 90 per cent. of ore with an average yield of 25 per cent. Cr_2O_3 is claimed in this process.

Where the grade of the ore is low due to the low Cr_2O_3 content of the chromite itself and not due to its admixture with other minerals, the beneficiation is not often practised with chrome ores because, though it may improve the Cr_2O_3 content, it seldom improves the chromium iron ratio. Investigations conducted recently in the Chemical Laboratory of the Mysore Geological Department on some of the types of chrome ores found in the State indicate, however, that it would be possible to improve this ratio to the desired extent by suitable chemical methods, keeping the cost of the beneficiated ore within reasonable limits. It is also reported (*Mineral Industry*, 1941, 50) that fusion of low grade ore with lime in an electric furnace has been found to give a concentrate with an improved Cr : Fe ratio, suitable for the production of either standard ferro-chrome, or the product known as Chrome-X, which may be used as a substitute for ferro-chrome.

Grading and Marketing

The value of the chrome ore depends upon the percentage of chromic oxide, Cr_2O_3 , it contains. The marketable ores range in quality from 40 to 55 per cent. Cr_2O_3 ; those exceeding 48 per cent. Cr_2O_3 being classed as high grade, and others below this and up to the limit of 40 per cent. as low grade. These limits, however, have been recently lowered, (*Mineral Industry*, 1941, 50). The present classification accepts 45 per cent. Cr_2O_3 as the minimum for the high grade ore, and 35 per cent. for the low grade. Ores containing less than 35 per cent. Cr_2O_3 might be classed as ferruginous chromite or chromic iron ore and those containing less than 10 per cent. would pass on to the group of chrome spinels like picotite and other varieties.

Most buyers are satisfied if the chromic oxide and the iron contents of the ore are stated, though sometimes the percentages of silica and alumina are also desired. Firms manufacturing ferro-chrome usually stipulate 50 per cent. chromic oxide, Cr_2O_3 , and the iron content not exceeding 15 per cent. According to the specifications of the California State Mining Bureau, metallurgical ore for ferro-chrome manufacture should have a minimum of 40 per cent. Cr_2O_3 and phosphorus less than 0.2 per cent. The chemical trade requires high grade ore containing more than 50 per cent. Cr_2O_3 , but it is not so particular about the iron content and allows a maximum limit of 16 to 17 per cent. The ore should be uniform and not highly siliceous (silica less than 6 per cent.) and should not contain a high percentage of alumina.

Ores for refractory purposes should contain low silica not exceeding 6 to 8 per cent. and some of the manufacturers accept ores of such type even though it may not contain more than 38 to 42 per cent. Cr_2O_3 . The following specifications are in use in the United States for the chrome ore to be used in the manufacture of refractories.

(1) Cr_2O_3	..	40-50 per cent.	
Fe_2O_3	..	15 per cent. (maximum)	
SiO_2	..	8	„
(2) Cr_2O_3	..	40	„ (minimum)
Fe_2O_3	..	15	„ (maximum)
SiO_2	..	6	„

Industrial Uses

Chromite finds an extensive application in industry and its uses may be considered

under the following three principal headings in their order of importance :—

- (a) Metallurgical,
- (b) Refractory and
- (c) Chemical

Generally high grade ore containing more than 48 per cent. Cr_2O_3 is used in the metallurgical and chemical industries and the lower grades for refractory purposes.

The United States of America, which is the chief consumer of chromite, is estimated to utilize annually about 45 per cent. of the ore in the metallurgical, 40 per cent. in the refractory and the remaining 15 per cent. in the chemical industries.

(a) *Metallurgical Uses*—The chief metallurgical uses of chromite are in the production of various alloys of chromium with iron, nickel or cobalt—the largely produced being the well-known product ferro-chrome, an alloy of chromium and iron. For production of ferro-chrome, high grade ore containing more than 48 per cent. Cr_2O_3 is required, but at present ores containing a minimum of 45 per cent. Cr_2O_3 , with sulphur and phosphorus contents less than 0.1 per cent., which have a ratio of chromium to iron of 2.8:1 or more, are being used. The refractory nature of the ore is also taken into consideration—the less refractory the ore is, the greater will be the advantage since the power consumption in the production of the alloy will be proportionately reduced.

Ferro-chrome is manufactured by the reduction of chrome ore (of the abovesaid specification) either in an electric furnace by means of carbon or silicon, or by the thermit process, and contains 60 to 70 per cent. chromium. While reducing the ore with carbon, the alloy tends to assimilate some quantity of carbon. Depending upon the carbon contents, two varieties of alloys are formed—High carbon Ferro-chrome and Low-carbon Ferro-chrome—the former containing about 4 per cent. or more of carbon and the latter containing up to 2 per cent. Of the two, the low-carbon ferro-chrome has much greater value since it is used in the manufacture of high grade alloy steels, particularly stainless variety.

A new process has recently been discovered in Canada wherein ferro-chrome can be manufactured from chromite containing very high percentage of iron (more than that required in the usual practice). From this, a new alloy called Chrome-X, which is reported to be a mixture of chrome-oxides and ferro-

chrome-silicon is manufactured. With this material, stainless steel can be manufactured in an open-hearth furnace instead of in the more expensive electric furnace.

Chrome steels of different grades and qualities are manufactured by using different proportions of chromium—from less than one per cent. up to 50 to 60 per cent.—either alone or mixed with certain proportion of other alloying elements like nickel, cobalt, manganese, tungsten, copper, molybdenum, titanium, vanadium, silicon, aluminium, columbium, nitrogen, sulphur, selenium, zirconium, etc. Depending upon the proportion of chromium used, the carbon content, and also on the other elements present in the alloys, a large range of properties may be obtained in these steels as regards their strength, toughness, hardness, high electrical resistance and resistance to wear, chemical corrosion and oxidation. Based on the percentage of chromium content, the chrome-steels may be classified in a very general way as follows :—

- (1) Low alloy structural and heat-treated high tensile steels containing up to 3.5 per cent. Cr.
- (2) Special purpose steels containing from 3.5 to 10 per cent. Cr.
- (3) Stainless steels containing from 10 to 16 per cent. Cr.
- (4) Chromium nickel stainless steels containing from 16 to 22 per cent. Cr.
- (5) High corrosion and oxidation resisting steels containing more than 22 per cent. Cr.

Depending upon their individual qualities, these various classes of special steels are used for the construction of lorries, tanks, bridges, motor car axles, railway wheel tyres, armour plates and so on.

Chromium steels of class 1 are largely used in automobile construction and in high-strength structural steels which are used for constructing lorries, tanks, railway carriages, etc. and for tool steels. Those which can be grouped in class 2 are generally of the low carbon variety, and on account of their excellent physical properties and moderate corrosion resistance they find a wide use in the chemical and petroleum industries.

The original stainless steels or rustless varieties as developed in Sheffield come under class 3. These steels are used for making cutlery and cooking utensils, and for producing hydraulic turbine blades, valves and fittings for high pressure steam service.

The chrome steels of class 4 include the super stainless steels and stainless chrome nickel steels. Steels grouped under this class are specially suitable for light weight structures where great strength is required, as in aircraft, superstructure of ships, high speed trains, etc. Addition of small proportions of molybdenum, tungsten, titanium, columbium, etc., to these alloy steels improves their resistance considerably to corrosion by various acids and other oxidizing agents.

In recent years some modifications have been effected in the chrome-nickel alloy steels of standard composition by replacing part of the nickel by manganese or copper, the former type yielding an alloy steel of a pleasing silvery appearance fit for decorative purposes, and the latter, due to its free machining qualities highly suited for rolling and fabrication.

Chromium steels of class 5,—those containing above 20 per cent. of chromium—are highly resistant to corrosion and oxidation. These alloys, with or without modifications, are employed for cast articles used in high temperature work. They can be had as sheets and rolled products and can be readily cast into any shapes like pump casings, impellers, etc. These steels offer good resistance to oxidation up to 1,100°C.

Chromium Metal is a lustrous greyish white metal with a slight bluish tinge, having a specific gravity of 7.14 and a melting point of about 1,830°C. The pure metal is very difficult to prepare; it is made by reducing chrome ore with silicon in the electric furnace or by the aluminothermic process. The purest chromium available, commercially, is produced by the electrolysis of chromic acid solution.

Even when 99 per cent. pure, the cast metal is hard, brittle, coarsely crystalline and not amenable to working and, consequently, has very little commercial use except in the compounding of non-ferrous alloys and for electro-plating purposes.

Nickel-plating is now being replaced to a large extent by chromium electro-plating since the latter is found to be more durable. Since 1929, the technique of chromium plating has been well developed in America, the plating being of two kinds, (1) light coating, the thickness of the coat being 0.00002 of an inch, for decorative and anti-tarnish purposes, for plating sanitary fittings, electrical appliances, stoves, coffee kettles, etc., and (2) heavy coating of about 0.01 of

an inch thickness for anti-wear and anti-corrosion, for silvering printing plates, automobile parts, plumbing fixtures, power plant fittings and numerous other articles. Recently there has been some improvement in the process of chromium plating in what is known as Nast Process in which the plating is said to be cheaper and will neither peel nor chip out. The chromium used for plating purposes forms, however, a very small proportion.

Chromium metal is used in the manufacture of a number of non-ferrous alloys and alloys of low iron content. Amongst these the Stellite group is of special importance. Stellite varies in composition between certain limits; but it is essentially an alloy of cobalt and chromium with some tungsten or molybdenum, containing from 40 to 90 per cent. cobalt and 10 to 30 per cent. chromium. The alloy is extremely hard, takes a good cutting edge and is specially suitable for high speed tool work. Another alloy, known as Ni-chrome has a composition of 60 per cent. nickel, 14 per cent. chromium and 15 per cent. iron. Its special application is as a high temperature resistance alloy and it is used for annealing boxes, carbonizing boxes, retorts, etc. Chromium-vanadium steel can develop a wide range of physical qualities by proper heat treatment.

A group of alloys containing essentially chromium, nickel, molybdenum and iron is notably resistant to hydrochloric acid. With 20 per cent. chromium, these alloys become resistant to strong oxidizing agents and are specially used for catalyst tubes, mixer parts, pickling boxes, etc. Chromium-copper alloys are employed to a small extent for electrical conductivity purposes; particularly at high temperatures. In cast copper alloys the addition of small quantities of chromium has been found to markedly restrict grain growth.

(b) *Refractory Uses*—Since chromite possesses high corrosion resistance properties and withstands resistance against high and also sudden temperature changes, it finds good many uses as a refractory material. Moreover, its chemically neutral character as compared to acid and basic properties of other refractories, is an additional advantage to use it wherever these latter substances cannot be used. For the manufacture of chrome-refractories, generally low grade ores containing 41-45 per cent. Cr_2O_3 and silica contents below 5 per cent. are used. However, ores relatively

high in silica and low in Cr_2O_3 can be used very successfully in the manufacture of composite chrome bricks. The amount of iron oxide present in the ore plays an important role. Iron content up to about 15 per cent. is tolerated and any increase of iron beyond this percentage reduces the refractory property of the ore. Apart from chemical properties, the physical condition of the ore also—especially the grain size distribution—has some effect on the refractory character. Deposits consisting of fine grained chromite cemented in thin films of matrix are preferred to other types of ore for this purpose. Chromite is used as a refractory material in three forms—(a) in lump ore as mined, (b) as chrome-bricks, and (c) as chrome-cements.

Until recent years chrome bricks were produced by firing bricks made from raw ore with various binders, consisting usually of some organic binding materials. The addition of a small quantity (5 to 10 per cent.) of magnesite to the batch is found to improve the quality of the bricks considerably. Chrome bricks are used for the lining of open-hearth basic steel furnaces. Unburnt chemically-bonded chrome bricks containing small amount of dead-burnt magnesite, is specially used in the front and back walls of open-hearth furnaces, bulk heads, etc., where high temperatures are met with.

Chrome paste made by wetting finely ground chrome ore, applied sometimes by means of a special gum, is used for patching corroded parts of furnace linings; and lumps of chrome ore, cemented with a mortar of finely crushed ore, are used to fill up the eroded cavities in the furnaces in the end walls. Finely ground chrome ore in a slurry form is also used to give a protective coating to the furnace roofs. Chrome ore with magnesite as pastes is used for repairing steel furnace linings and it is found that these are cheaper and more economical than the chrome magnesite bricks or magnesite bricks.

Chrome refractories, in addition to their use as linings for the basic open-hearth furnaces have also been employed in the construction of arches of electric steel furnaces, for lining of copper and nickel smelting furnaces, for parts of combustion chambers of high pressure steam boilers, and for the lining of the roasters employed for soda recovery in the soda process of paper pulp making. The chrome refractories are preferred to magnesite and silica-alumina mixtures for use in the furnaces, due to their longer life and low cost of production.

It is usual to add, as stated above, small proportion of dead-burnt magnesite for making chrome bricks; but during the last few years larger quantities are being mixed evolving a new type, the chrome-magnesite brick, which is found to be eminently suitable for use in steel furnaces.

Another type of refractory product, known as Siemensit is made by fusing a mixture of the slag produced during the manufacture of ferro-chrome, with chrome ore, magnesite and alumina. Its refractoriness exceeds $2,000^\circ\text{C}$. and its porosity is below 2 per cent.

In recent years there has been a great advance in the use of unburnt chrome bricks, in which both olivine and magnesite are combined with chrome ore. These are said to resist, satisfactorily, spalling at high and fluctuating temperatures and being lower in cost than the chrome-magnesite bricks, they seem to be replacing the latter.

In 1930, refractory brick composed of a combination of chromite and silica was manufactured wherein the two materials result in the production of a brick which combines the two properties of high load bearing ability (as compared to chromium refractories which are mechanically weak under load at high temperatures but resist alkaline and acid slags) and refractoriness with improved slag resistance.

Recent ceramic investigations conducted in England prove that a refractory compound of chromite and diaspore excels the one made of plain chromite, both in the load-bearing capacity at usual steel making temperatures and in resistance to spalling under sudden, large temperature changes.

(c) *Chemical Uses*—In this branch of industry, chromite is used mainly in the manufacture of its important salts—chromates and dichromates of sodium and potassium, which in their turn form the bases for the production of other salts of chromium largely used in various chemical industries. For the preparation of chromium salts, the chromite ore used should be, as already stated, of a fairly high grade (48-50 per cent. Cr_2O_3) with silica contents below 6 per cent. and alumina content as low as possible. The chromates and dichromates including the other chromium salts prepared from them like chrome alum, chromium acetate, chromium chloride, etc., are extensively used in the following industries :—

(1) Tanning, (2) Dyeing, (3) Pigment, (4) Ceramic colours (5) Glass colouring and other industries.

(1) *Tanning* is the important chemical industry which consumes fairly large quantities of chromium salts. Chrome-tanned sole leather is stated to have exceptional wearing qualities.

(2) *Dyeing*. In dyeing, especially of woollen clothes, chromates and dichromates of sodium and potassium, chrome alum (chromium chloride, chromium fluoride), and chromium acetate are used. These salts act as mordants and also impart colouring properties to the woollen goods.

(3) *Pigments*. Lead chromate forms the main constituent for the manufacture of various other pigments. Normal lead chromate has a lemon-yellow colour. Basic lead chromate possesses a red colour. Lead chromate mixed with a mixture of potassium and sodium nitrates produces vermilion pigment. Normal lead chromate mixed with prussian blue, yields a green pigment. A few other pigments are prepared out of anhydrous and hydrous chromic oxides, the former yielding the *ultra-marine* green, and the latter when mixed with boric acid, or ammonium phosphate, yielding different shades of green.

(4) *Ceramic Colours*. For ceramic purposes, either chromite by itself, or its products potassium dichromate, lead chromate, and chromic oxide are used. When chromite is used, it has to be crushed and very finely ground so as to pass through 300-mesh sieve. It is used to give a pearl-grey colour to flooring tiles and electrical porcelain.

If the chromium salts have to be used, they have to be mixed with a suitable flux and calcined. Under reducing atmosphere the chromic oxide forms green pigment; and in an oxidising atmosphere it forms a buff or red coloured pigment. The pigments may be used to colour the clay body before or after firing.

(5) *Colour-Glassmaking*.—Finely ground chromite—from 2 to 6 per cent.—is added to the batch (raw mixtures of different materials used in making glass) to give various shades of green to the glass. The depth of colour depends upon the proportion of chromic oxide added to the batch. Small quantities of potassium dichromate, iron and copper when added to the batch, impart blue and green colour to the glass.

Production and Estimated Reserves

The accompanying table gives an idea of the quantities of ore which each of the

important producing areas in India have raised up to 1939.

Reliable data to ascertain the actual quantity of ore which may still be in reserve in each of the several chromite-bearing areas noted above are lacking.

In Baluchistan, the quantity of ore which has been extracted till now has far exceeded the earlier conservative estimates. It appears that the mode of occurrence of the ore bodies, as lenticles and irregular veins, makes it difficult to estimate correctly the quantities they are likely to yield.

In Mysore, it was estimated in 1918, that the chromite deposits in the Nuggehalli schist belt, in Hassan district, contain in the aggregate about half a million tons of ore of all grades, of which the high grade ore yielding more than 47 per cent. Cr_2O_3 , would amount to about 90,000 tons. In the Mysore District, Sinduvalli is the only mine which has been producing high grade ore, and in this mine the ore bodies seem to be nearing exhaustion. The low grade ores in this district range from 30 to 45 per cent. Cr_2O_3 , and may yield in the aggregate about 20,000 tons. In the Chitaldrug and the Kadir Districts the chromite ores are too poor in Cr_2O_3 to be of much commercial value.

Bihar has produced nearly a hundred thousand tons of chrome ore till now, but there is no information on the definite quantities of ore which the region is likely to have in reserve still.

In Bombay, the quantity of ore available from the Kanakauli and Vagda areas in the Ratnagiri District, are estimated to amount to about 67,000 tons of low grade ores yielding about 30 to 39 per cent. Cr_2O_3 .

In Madras, the recently discovered deposits in the Krishna (Kistna) District are reported to yield about 50,000 tons of ore and this, however, needs confirmation by actual investigations. The deposits in the other areas in Madras, and also in the other parts in India do not seem to be of much commercial importance.

This available information, which is rather imperfect, indicates that India has a reserve of about 1,00,000 to 2,00,000 tons which may be classed as high grade containing 45 per cent. and above of Cr_2O_3 , and the remaining as low grade yielding 30 to 44 per cent. chromic oxide. These estimates, which are very approximate, may turn out conservative if the deposits in the several areas are investigated by intensive prospecting.

Table showing the production of Chromite in India for the period 1924-39

Year		Baluchistan	Mysore	Bihar and Orissa	Eastern States Agency	Bombay	Total
1924 ..	Tons	26,710	17,612	1,140	—	—	45,462
	Rs.	3,82,213	1,85,948	19,241	—	—	5,87,402
1925 ..	Tons	18,198	16,216	3,038	—	—	37,452
	Rs.	2,65,271	1,99,735	69,274	—	—	5,04,280
1926 ..	Tons	14,832	16,927	1,623	—	—	33,382
	Rs.	2,17,715	1,58,116	37,028	—	—	4,12,859
1927 ..	Tons	14,534	40,121	2,552	—	—	57,207
	Rs.	2,18,014	6,13,512	49,431	—	—	8,80,957
1928 ..	Tons	15,002	28,288	2,165	—	—	45,455
	Rs.	2,25,030	4,91,689	48,949	—	—	7,65,668
1929 ..	Tons	17,905	28,511	3,149	—	—	49,565
	Rs.	2,66,761	5,06,568	68,440	—	—	8,41,769
1930 ..	Tons	25,387	20,196	5,101	—	—	50,684
	Rs.	3,77,980	3,90,254	99,222	—	—	8,67,456
1931 ..	Tons	12,189	4,975	2,749	—	—	19,913
	Rs.	1,81,291	96,466	37,269	—	—	3,15,026
1932 ..	Tons	228	9,999	7,638	—	—	17,865
	Rs.	3,420	1,63,283	1,08,972	—	—	2,75,675
1933 ..	Tons	2,702	5,756	7,068	—	—	15,526
	Rs.	40,530	80,811	1,01,904	—	—	2,23,245
1934 ..	Tons	2,346	12,220	7,010	—	—	21,576
	Rs.	35,190	1,82,639	92,237	—	—	3,10,066
1935 ..	Tons	7,642	20,088	11,397	—	—	39,127
	Rs.	1,10,860	2,42,591	1,26,514	—	—	4,79,965
1936 ..	Tons	21,089	21,344	7,053	—	—	49,486
	Rs.	3,07,505	2,13,088	83,899	—	—	6,04,492
1937 ..	Tons	27,209	26,400	7,678	520	500	62,307
	Rs.	4,05,215	3,12,916	1,07,258	5,200	5,000 (Estimated)	8,35,589
1938 ..	Tons	21,892	16,969	5,194	94	—	44,149
	Rs.	3,26,014	2,55,620	99,928	940	—	6,82,502
1939 ..	Tons	13,952	30,708	4,476	—	—	49,136
	Rs.	2,07,430	3,26,863	1,01,218	—	—	6,35,511

Chromite Industry in India

Till recently chromite was being produced in India solely for purposes of export, and very little ore was being consumed in local industries. During the six years, 1934 to 1939, India produced 2,65,781 tons of chromite averaging, approximately, 44,300 tons per year—the highest production during the period being about 62,300 tons in 1937. It is not clear what quantity of the ore produced is actually consumed locally in India. Coulson estimates that it is not more than a thousand tons per year.

Mysore has been consuming during the last five or six years about 800 to 1,000 tons per year of locally raised chrome ore,—about 300-400 tons of ore per year for furnace lining in the Iron and Steel plant at Bhadravati, and about 500 tons per year, of high grade ore, for the production of sodium dichromate in the factory at Belgula which came into operation in 1941. Recently several small concerns have sprung up for the production of sodium dichromate in Bombay, Cawnpore and other places, and these, perhaps, consume about a thousand tons per year. Assuming the *Tisco* and other iron works of India consume another 1,000 tons per year, the present local consumption of chromite produced in India is not exceeding 3,000 tons per year—in other words, less than 7 per cent. of its total production.

Scope for Expansion

Dichromate Industry.—In pre-war times India was importing annually some 250 tons of potassium dichromate, and about 750 to 800 tons of sodium dichromate, the total imports of these two salts for the six years from 1935 to 1939 amounting to 6,162 tons. The present war conditions which have cut off the foreign sources of supply of these chrome salts, so very essential for the tanning industry, have given an impetus for the setting up of sodium dichromate factories at several places. These factories have been consuming now about 1,000-1,500 tons of chromite, per year, of high grade ore containing 46 per cent. and above of chromic oxide. If this industry becomes stabilized in India, after the war some 2,000 tons or more of high grade ore are likely to be consumed locally every year for this purpose. It is stated that the dichromates are now being used in America very largely, in addition to tanning, to give a coat of paint to iron and steel, in preference to lead

chromate and other yellow pigments. If this new application of the dichromates comes into practice in India, the demand for these chrome salts and, hence, for the chrome ore will increase still further.

Ferro-Chrome.—Some of the high grade chrome ores in Baluchistan conform to the standard specification of chromite for the production of ferro-chrome in having their chrome iron ratio not below 2.8 : 1. The high grade ores in Mysore contain too high a proportion of iron to come within the standard specification, the ratio of chromium to iron in the Byrapur ore being 2 : 1 and of Sinduvalli ore, 2.4 : 1. The high grade chrome ores of Singhbhum, like those of Mysore, contain too high a proportion of iron to come within the standard specification.

Mysore has been contemplating from a long time to set up a small plant for producing ferro-chrome to the extent of some 3,000 tons per year. Experiments conducted some years back (in 1929) to ascertain the possibility of manufacturing 60 to 70 per cent. ferro-chrome, of both high and low carbon types, had been fairly successful; but investigations were discontinued in view of the fact that the results obtained in different experiments were not consistent right through.

The ratio of iron to chromium in the Mysore and the Bihar ores is no doubt higher than normal for the production of the 70 per cent. ferro-chrome; but recent researches in America, in the metallurgy of chrome, have shown that the low grade ores and ores having a high proportion of iron can be used successfully for the purpose and for the production of stainless and other classes of chrome steels. By suitable treatment it would be possible, without prohibitive costs, to increase the chrome iron ratio in the chromite ores to the desired extent. Consequently, the chemical composition of the ore, by itself, does not form any serious handicap for the local consumption of chrome ores for producing ferro-chrome and other chrome alloys. With the development of cheap power, there should be a bright future for the smelting of chrome ore in electric furnaces for those purposes.

War conditions have set up a very large demand for special steels. The demand in India for high-speed tool steels required in various industries like the railway and engineering workshops, Government ordnance factories, etc., is increasing very considerably.

India has been planning to take up the manufacture of aeroplanes, automobile engines and spare parts, armour plates, etc., and when these come into operation in the near future, a large quantity of chrome ore will be consumed locally for the production of ferro-chrome and other steel alloys.

Refractories.—The demand for low grade chrome ores, containing 40 per cent. and above of chromic oxide, for lining iron and steel smelting furnaces, for making bricks and other refractory products is also likely to increase considerably.

Consequently, as remarked by Coulson, with the anticipated expansion of these several chromium industries, it is hoped that India will soon take its rightful place as a nation that not only produces chrome ore but also utilizes it in a widespread system of manufacture.

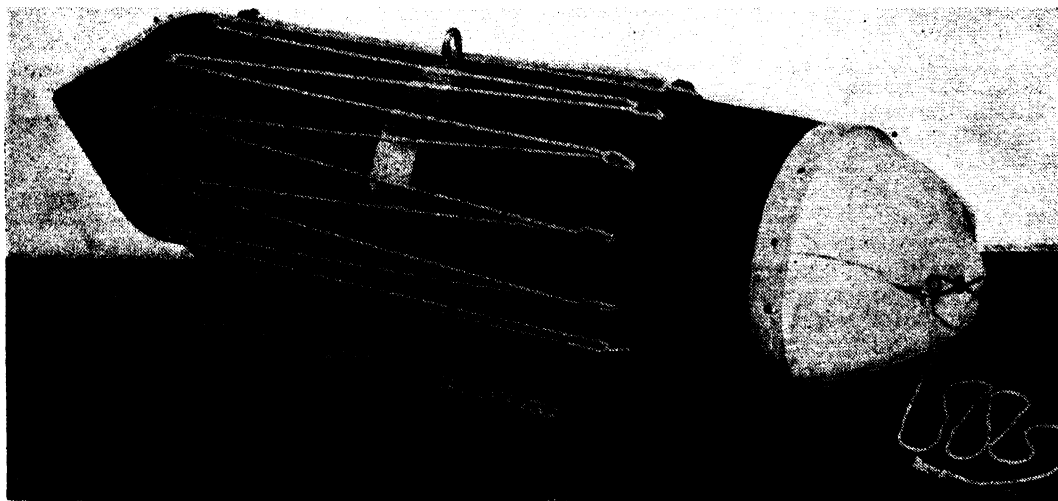
Selected References

- Allen, R., and Howling, G. E., *Chrome ore and chromium*, Imperial Inst., London, Mineral Resources Series, 1940.
 Bhadauria, B. S., *Quart. Jour. Geol. Min. Met. Soc. Ind.*, 1939, **11**, 123-133.
 Brown, J. Coggin, *India's Mineral Wealth*, 1936, 137-140.
 Coulson, A. L., *Rec. G.S.I.*, 1941, **76**, Bull. Economic Minerals No. 2, 1941.
 Fermor, L. L., *Rec. G.S.I.*, 1921, **53**, 1921, 255-256.
 Humphrey, I. B., *Eng. & Min. Jour. N.Y.*, 1943, 62-65, 68-70.
 Iyer, L. A. N., *Rec. G.S.I.*, 1939, **74**, 1939, 372-385.
 Mahadevan, C., *Econ. Geol.*, 1929, **34**, 195-205.
 Mineral Industry. "Chromite," in Vols. 36, 37, 38, 39, 41, 46, 47 and 48.
 Rama Rao, B., *Quart. Jour. Geol. Min. Met. Soc. of India*, 1942, **14**, 13-15; 1943, **15**, 167-173.
 Sen, A. M., *Mys. Geol. Dept., Bull.* **11**, 1931, 65-88.
 Smeeth, W. F., and Sampat Iyengar, P., *Mys. Geol. Dept. Bull.* **7**, 1916, 110-116.
 Venugopal, V. T., *Mys. Geol. Dept., Popular Studies*, No. 2, 1941.

AUSTRALIAN INVENTIONS AID WAR EFFORT

WHEN the Australian Army Inventions Directorate was established in March 1942, members of the Services and civilians were asked to submit ideas that might prove helpful. Soon after its establishment, the Directorate was faced with the task of evolving containers in which food and other supplies could be dropped accurately for advancing troops. In co-operation with a team of U.S. Army and Air Force officers, a device known as the *storpado*, composed of compressed paper, roughly shaped like a

torpedo, with a shock-absorbing percussion head at one end and a parachute pack at the other, was evolved. It is now widely used in the islands north of Australia by Australian and U.S. forces, and by the British Army in Burma. The device can drop 200 lbs. packages successfully. A special shock-absorbing package for small arms ammunition and a parachute made of hessian and only 12' in diameter, as against the 24' silk parachute normally used, have been developed for use with the *storpado*.



STORPEDO for dropping supplies. It consists of shock-absorbing percussion head, body containing equipment to be dropped and parachute and ripcord.

PROF. J. K. CATTERSON-SMITH

IT is with the deepest regret that friends of Prof. Catterson-Smith in India, and particularly his old students of the Indian Institute of Science, heard the news of his untimely death towards the end of January 1945. In his passing away at the comparatively early age of 58, the electrical engineering profession has lost an outstanding personality, and Indian industries an enthusiastic advocate.

Professor John Keats Catterson-Smith was born on the 25th December 1882 and received his early education at the City of London School. For his technical training, he went to the Birmingham University. Here he won the Bowen research scholarship and published his investigations on D.C. motors, transformers and rotary converters. After his three years' stay at *Siemens Dynamo Works*, Trafford, he was appointed Lecturer in Electrical Engineering at the University College, Liverpool. He was later appointed Chief Assistant to Professor Silvanus Thompson at the City and Guilds of London Technical College, Finsbury.

In the year 1915, during the First World War, Prof. Catterson-Smith joined the Navy in the R.N.V.R. During this period he worked on radio and supersonic developments and collaborated with Dr. Eccles, F.R.S., in solving some of the problems connected with facsimile transmission. He saw active service in a submarine and was raised to the rank of Lieutenant-Commander. After the war he returned to his post at Finsbury and carried out a number of investigations on the audio-frequency amplifier design and theory of inter-valve transformers.

His association with India dates back to the year 1923 when he was invited to occupy the Chair of Electrical Technology at the Indian Institute of Science, Bangalore. He came here with ripe experience in teaching and research and occupied the Chair for over seven years with great distinction. During his period the Department of Electrical Technology at the Indian Institute of Science witnessed phenomenal expansion. He laid the foundation of higher training in Electrical Communication Engineering for the first time in India and equipped an up-to-date radio communication laboratory. This has, for a long time, adequately

served the needs of training and research on the subject. His other equally important contribution to the technical training in India was the installation of a high voltage laboratory. This is now serving as a nucleus for high voltage engineering work in India. The equipment of this laboratory compares favourably with the then similar laboratories in other parts of the world.

Professor Catterson-Smith was an admirable teacher and he was eminently successful with his students. Wholly devoted to his subject, he created an enthusiasm in those who worked under him. He was extremely popular with the students and succeeded in winning their confidence to a remarkable degree. He viewed the difficulties of his students with an understanding eye and earned the gratitude of many by the ready way in which he espoused their cause and furthered their interest.

He was an ardent believer in the industrialization of India and always showed genuine interest in the development of Indian resources. The present porcelain and transformer factories at Bangalore owe their origin entirely to his initiative.

He founded the Electrical Engineering Society, of which he was the first President. *Electrotechnics*, which now serves as the only medium for the discussion of electrical engineering problems in India, owes its origin to his zeal and enterprise. To his last days he maintained an intimate contact with this *Journal*. His last contribution to it on the direct reading machine of hyperbolic functions is now in the proof stage.

His creative genius has earned for him a lasting place in the field of electrical engineering. In the words of one of his collaborators—"His was one of those minds that restlessly endeavoured to improve the operation of every machine encountered. This passion for improving and investigating continued in him to the end of his life." His last contribution in this direction was an improved electrical telemechanism of great ingenuity.

We would tender our most sincere condolences to Mrs. Catterson-Smith and other members of his family over the grievous loss they have suffered.

S. P. CHAKRAVARTI.

γ - HEXACHLOROCYCLOHEXANE (GAMMEXANE)*

By Dr. ROLAND SLADE

UNTIL recently the principal insecticides in commercial use were pyrethrum, derris, nicotine, hydrocyanic acid, *p*-dichlorobenzene, various organic isocyanates, and the well-known poisons discovered by the alchemists, arsenious oxide, arsenites and lead salts. Of these insect poisons, hydrocyanic acid and the active principles of pyrethrum and derris, namely, the pyrethrins and rotenone, affect insects in the smallest doses and the pyrethrins and rotenone are not dangerous to mammals. Since pyrethrum and derris are expensive to produce, and the supply is limited, investigators have for some years been looking for chemicals easily synthesized which would be as effective as the pyrethrins and rotenone. From 1934, over a period of five years we, in *I.C.I.*, investigated several thousand organic and other chemicals prepared in our various laboratories. The general method of investigating the toxicity of chemicals was to determine the concentration necessary to obtain a 50 per cent. kill on a series of standard insects. Among the insects used were grain weevils, flies and locusts, mosquitoes and certain aphids.

During these five years we found many substances which were poisonous to insects, but none of them was so effective as the pyrethrins or rotenone. Five or six years ago we changed the method of attack in our entomological laboratory and instead of testing large numbers of chemicals, we selected certain insect pests and sought for the chemicals and methods best suited to fight them. In this work we used the accumulated knowledge of the previous five years when we had put many substances through our standard tests. Early in 1942 we were looking for a substance to kill the turnip flea beetle, when we tried several chemicals, including heptachlorocyclohexane (monochlorobenzene hexachloride) and octo-chlorocyclohexane (*o*-dichlorobenzene hexachloride). A sample of 1.2.3.4.5.6.hexachlorocyclohexane (benzene hexachloride, the chemical formula of which is $C_6H_4Cl_6$ or 666 for short) was also tested and this was found to be promising. It was prepared by chlorinating benzene in the presence of light and crystallizing the product from benzene. The results of trials against a number of insect pests, both in the laboratory and on the small field scale in the summer of 1942, were most encouraging, but the results were not as consistent as we expected them to be.

We investigated the inconsistent action of different samples of 666; both the possibility of an impurity being the active principle and also the toxicity of the various isomeric forms in which 666 was known to exist, were examined.

Late in 1942 pure specimens of the α - and β -isomers of 666 were prepared by J. C. Smart and their toxicity to insects investigated. It was found that both isomers were relatively inactive to weevils, the γ -isomer was isolated and found to be more toxic to weevils than any substance which we had ever tested. It was thus established that the insecticidal action of 666 was due almost entirely to the presence of γ -1.2.3.4.5.6.hexachlorocyclohexane which I shall call Gammexane. The active principle of 666 is present to the extent of 10-12 per cent. in the crude material.

Preparation of Gammexane

The crude material is treated with a limited amount

of methanol, a solvent in which the α - and β -isomers are relatively insoluble. Separation of the solid product (I) leaves a solution containing the γ - and Δ - isomers and other highly soluble chlorinated bodies, very little α and some β . On evaporating the solution a small crop of practically pure γ - (II) is thrown down. As evaporation is continued the next crop of crystals contains γ - and β - Pure γ - may be readily prepared from (II) by recrystallization from chloroform.

Structure of the Isomers

Considerations of the strain involved in the formation of the sixteen possible configurations for the hexachlorides by reason of the close approach of chlorine atoms in many cases suggests that there are only five probably strainless forms of benzene hexachloride, two of which are mirror images. There are four isomers of benzene hexachloride described in the literature and confirmed by the present work. The structure of the β - isomer is known. The structures of the remaining isomers are not yet known with certainty but may be surmised with some assurance. The structures to be designated are shown by the models depicted in Fig. 1.

Properties

In the pure state the isomers of benzene hexachloride are well defined, colourless crystals, practically insoluble in water, soluble in organic solvents, practically inodorous and possessing bitter tastes. The m.p. of gammexane is 112.5°C. The β -isomer is comparatively less soluble than its isomers in the solvents studied, the γ - and Δ -forms being relatively more soluble.

The hexachlorocyclohexanes possess considerable chemical stability. In the presence of alkalis such as lime water at 60° C. or even at ordinary temperatures, hydrogen chloride is removed from the benzene hexachloride molecule giving a mixture of the isomers of trichlorobenzene. This effect may also be brought about by mixing 666 with dry lime.

0.19 gm. of gammexane per kg. of body weight was necessary to obtain a 50 per cent. kill (in 7 days) of rats when introduced into the stomach. Experiments on chronic toxicity showed that rats could be fed 30 mgs. of gammexane per day for five weeks without effects of any kind being produced, and 100 mgs., of the mixture of isomers was fed daily with the food for two months to rats without producing any effect. It appears to have no effect on the skin and subcutaneous injection of 100 mgs. of gammexane per kilo body-weight killed 25 per cent. of the rats. The rest were severely affected but recovered in three days. Against gold-fish, however, gammexane was distinctly toxic at a concentration of one part per million.

There appears to be little or no danger to animals or men by the use of 666, but with all new chemical materials, we have to watch carefully the effect upon the skin. It is difficult to deduce the effect upon man from experiments on other animals.

Insecticidal Preparations

A finely divided powder containing 20 per cent. of crude 666 and 80 per cent. gypsum, which was further diluted with selected materials, gave a satisfactory substitute for ground derris for use on

* From the Hurter Memorial Lecture.

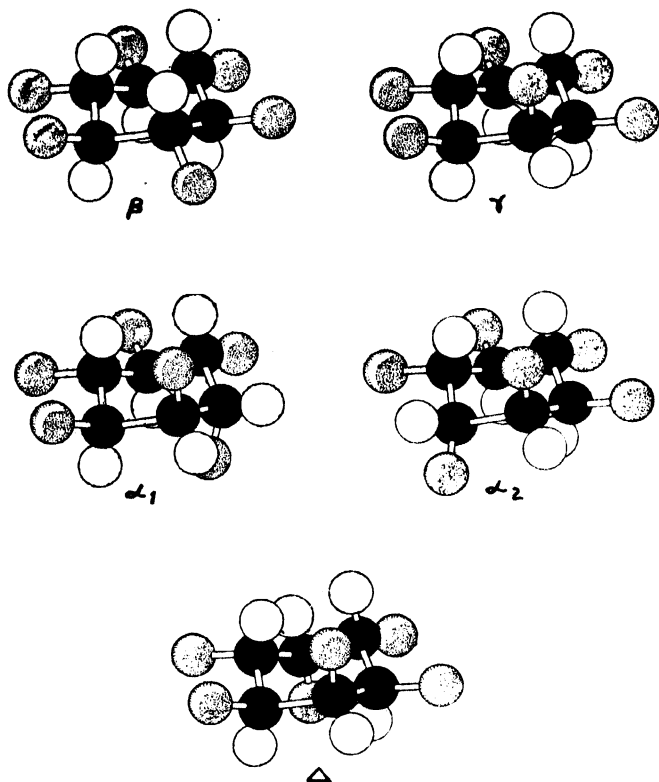


Fig. 1. THE ISOMERS OF HEXACHLORO-CYCLO-HEXANE (GAMMEXANE)
The diagram shows the five isomers of hexachloro-cyclo-hexane. Chlorine (spotted circles), carbon (black circles) and hydrogen (white circles) atoms are distinctly shown. Only the γ arrangement has astonishing insecticidal properties.

crops. Solutions containing 5 per cent. gammexane or more may be diluted for use with kerosene or other suitable oil. By the addition of an emulsifying agent such as selected Turkey Red oil, concentrated solutions can be prepared, which on the addition of water give a stable emulsion suitable for use in the field.

Another gammexane preparation designed for use with water as diluent is the dispersible powder and suitable types may be prepared, either from crude 666 or from the solid product resulting from the removal of α - from the crude, by incorporating an adequate amount of "Goulac," i.e., waste lye resulting from the sulphite treatment of cellulose.

Unlike many insecticides, gammexane has proved to be exceptionally stable to high temperatures. This enables it to be applied by volatilization from hot plates or by other heating methods, producing the insecticide in the form of a "smoke." By these means the insecticide may be used directly against insects or to give a toxic film on walls, etc. This method of application is being investigated further.

Gammexane has been shown to be highly toxic to many insects. Against certain pests it has proved more toxic than any other insecticide examined. An insecticide effective at such low concentrations and against such a wide range of insects and related pests finds use in many fields.

Agricultural and Other Uses

In trials against the flea beetle (*Phyllotreta* spp.) the product proved to be outstanding, giving better results than the derris dusts then in use. Considerable acreages of seed beds have been successfully treated for the control of blossom beetle (*Meligethes aeneus*) and mustard beetle (*Phaedon cochleariae*). The material was extraordinarily toxic in locust baits; it was, in fact, much more toxic than anything hitherto used.

Successful results have been obtained against a wide variety of insects. As examples may be cited caterpillars of many kinds, including winter moth (*Cheimatobia brumata*) and cabbage white (*Pieris* spp.). Preliminary results from abroad show that gammexane is highly toxic to such pests as melon worm (*Diaphania hyalipata*), southern armyworm (*Lamphygma eridana*) and beet webworm (*Pachyzancla bipunctalis*) in the U.S.A., various other beetles such as Colorado beetle (*Leptinotarsa decemlineata*), against which early trials show promise, the pea and bean weevil (*Sitones lineatus*) and the apple blossom weevil (*Anthonomus pomorum*).

Gammexane kills certain wasps and ants (e.g., *Vespidae* and *Lasius* spp.). Like other insecticides it is toxic to bees and methods of application to fruit trees must be selected with great care for bees are largely responsible for carrying the pollen of fruit trees.

The product may be of considerable value as a soil insecticide. A preliminary experiment in the field against wireworm leads us to hope that at last we may have found a means of fighting this pest which is responsible for the failure of so many farmers' crops in Britain.

Gammexane is highly effective against bed-bugs. For this purpose a suitable form is the solution in "Dec" which is diluted for use with a suitable spraying oil, such as odourless distillate. Used in this way no damage is done to painted or French polished surfaces, so that it can safely be used for practically any insecticidal purpose in the home. It is highly successful as a killer of crickets (e.g., *Gryllus domesticus*) and cockroaches (e.g., *Blattella germanica*, *Blatta orientalis*). A dust preparation for the control of these pests is now available.

More important uses are concerned with the control of flies and mosquitoes. Against adult flies (*Musca domestica*, etc.) the paraffin solution has proved exceedingly toxic. Since it does not give the immediate paralytic effect or knockdown which is desirable for some fly spray uses, the addition of a little pyrethrum is advantageous. A spray of the same type is effective against adult mosquitoes.

Among the pests of stored products, the grain weevil, *Calandria granaria*, has proved exceedingly susceptible to gammexane. Dusts applied to the grain giving a concentration as low as one part of gammexane per million of wheat have proved toxic.

No effect can be detected on flour subsequently made from the wheat or in loaves made from the flour even when the insecticide is used at considerably higher dosages.

Another pest which can be controlled is the hide beetle, which causes considerable damage to stored hides. Only limited tests against other pests of stored

products have been carried out and one of these, the flour moth (*Ephestia kuhniella*), seemed resistant to the preparations employed. Tests against the clothes moth (*Tineola bisselliella*, etc.) are very promising.

The product has the merit of acting as a stomach poison, as a contact agent or as a fumigant.

2254/2

EXPLOSIVES *

By MAJOR B. N. MITRA

(Inspectorate of Military Explosives, Kirkee)

THE first recorded history of explosives may be said to begin with black powder. The Greek Fire of the seventh century A.D. was its hoary precursor. From the voluminous and conflicting evidence before us it is almost difficult to trace the black powder back to its origin. It has been fathered by many. The principal claimants are the Chinese, the Hindus, the Greeks, the Arabs, the English and the Germans. According to Halhead (1776), gunpowder had been in India 'far beyond all periods of investigation.' Gunpowder was certainly known to Berthold Schwartz and to Roger Bacon in the thirteenth and fourteenth centuries—one a German monk and the other an English friar. It is said that this German monk tried to make a gold paint and invented gunpowder and gun instead. History of science records the birth of more than one discovery in an ecclesiastical cradle.

There is a big gap from gunpowder to modern history of explosives, over a period of five hundred years. With the great strides made by science from the fifties of the last century, progress in explosives also kept pace. The discovery of nitroglycerine in 1846 by Sobrero, Professor of Chemistry at Turin, opened up new possibilities. This invention of N.G., however, remained undeveloped for a long time. It is to the genius of Alfred Nobel (1833-96) that we owe the genesis and development of explosives based on nitroglycerine. Dynamite is one such. Dynamite is nitroglycerine absorbed in kieselguhr.

No less fascinating than the history of nitroglycerine is the history of the nitrocelluloses. Of these, the discovery of gun-cotton is largely due to Schonbein. The great departure he made, and what has come to stay as the standard procedure of manufacture, was to use as nitrating agent a mixture of nitric and sulphuric acids instead of nitric acid alone. There is an amusing story connected with the discovery of gun-cotton. It appears that Schonbein, like many other inventors, often used his wife's kitchen for his experiments. One day he was distilling nitric acid and sulphuric acid on the kitchen stove when the flasks broke. He grabbed the nearest thing, his wife's apron, which seemed none the worse for the treatment, and hung it up to dry in front of the kitchen fire. Suddenly there was a puff and the apron went up in flames. Being a true scientist, although perhaps a cowardly husband, he repeated the experiment and discovered that the treatment of cotton with a mixture of nitric and sulphuric acids resulted in a highly inflammable compound.

The discovery of nitroglycerine and of gun-cotton may well be regarded as the genesis of the modern explosives. Before these are described in detail, it would be proper to define an explosive. Many phenomena indicate that an explosive is, in general, to be looked upon as an unstable system, which on being suitably initiated, undergoes instantaneous transformation mostly into gaseous products, which exert a sudden and intense pressure on the immediate surroundings. To describe them objectively, explosives have been likened to a cone just held to stand on its apex, or to a ball resting in a cup-shaped recess at the top of an incline, in either case a touch of energy being required to convert the potential energy into kinetic.

To explain an explosive effect, it would be well to describe in brief a shell and how it bursts. A shell is a metallic casing which contains a high explosive as the main filling. Contiguous with the filling in the shell is the exploder system composed of certain types of explosives functionally known as the intermediaries. The shell is also fitted with a fuze mechanism, containing initiators which are highly sensitive to percussion or impact. The fuze goes off on impact and starts an impulse which sets off the exploder system, resulting in an exaggerated detonation wave. This in turn detonates the main filling, instantaneously giving as the products of combustion, a mixture of very hot gases under extremely high pressures. Consequently the shell bursts into small fragments flying all round with great force and causing damage to objects in the line of their flight.

Apart from the shell burst, there is also the blast effect of an explosion in its immediate vicinity. The rapidity with which energy is liberated following an explosion, results in the first instance, in an increase in the resistance of the envelope to the disturbance (explosion). When the envelope is air, as it most often happens, there is a local pressure which is at once sudden and intense. It would take some distance and time for this pressure to be dissipated and during this interval there is set up a mechanical wave with its usual characteristics including alternate zones of compression and rarefaction. This is the so-called shock-wave, responsible for the blast effect which follows in the wake of an explosion. Depending upon the intensity of the shock-wave, the distance from its source, and its phase, an object will be affected.

The shock-wave set up in rigid bodies, as when a bomb bursts after travelling some distance under-

* Based on an address delivered before the *Indian Science Congress*, Nagpur, 1945.

ground, is more destructive in its effects, as witnessed in bomb craters and damage to buildings sometimes far removed from the bombed area; in the last case the shock-wave transmitted laterally by underground shakes the foundations of buildings in its path.

Classification

Broadly speaking, the shells that burst and cause damage, the mechanism bursting the shells, the motive power required to project the shells from the gun, demolitions carried out by the sappers, the various incendiary and pyrotechnic effects obtaining in devices like Molotov's cocktails, bombs, flame throwers, signalling designs and smoke compositions, these and many more require and utilize explosives. These are divisible on a functional basis into (i) Propellants, (ii) High Explosives, and (iii) Miscellaneous which include gunpowder, pyrotechnic and other compositions.

Propellants.—The agency or propellant used in modern cannon is a moderated explosive, which on suitable initiation just burns to produce gases which force out the projectile. The weight of the shell (sometimes $\frac{1}{2}$ ton and more) and the range determine the charge of the propellant to be used, and this is fixed for a cannon of a particular bore. In the present war, H.M.S. "Hood," it might be remembered, was sunk by an unfortunate hit on its magazine by an enemy shell said to have been fired from 22,000 yards range.

From the functions just described of a propellant, it follows that a sustained rate of burning to ensure regular ballistics of the projectile, freedom from flash and smoke for tactical reasons and for safety to the gun crew and neighbouring stores, and stability in storage are some of the more important requirements of propellants, of which the best representative is cordite.

High Explosives.—High explosives are subdivisible into (a) initiators, (b) intermediaries and (c) main fillings.

Initiators.—These are hypersensitive chemical compounds with a small but concentrated source of energy, and include the class of compounds like fulminates and azides. Typical are mercury fulminate and lead azide. Another compound of this series coming into vogue in recent times is lead styphnate, the salt of trinitro-resorcinol.

Intermediaries.—The main intermediary of the present age in the exploder system of a shell is tetryl. It was born in the flood of synthetic organic chemistry that the German universities chose to let loose upon the world in the latter half of the last century. It formed the subject matter of the dissertation of Merten, a Leydon don, and thereafter put to bed in Beilstein. In the stampede preparatory to the last war, some one trod on it and it joined the fray. Nitration of dimethylaniline gives trinitro-phenyl-methyl-nitramine, that is, tetryl, also known as Composition Exploding.

Main Fillings.—Foremost among the class of compounds used as shell fillings are the nitro compounds, the first to be used being picric acid.

T.N.T., i.e., 2:4:6 trinitrotoluene, is a comparatively new-comer into the field of military explosives, having been first used in quantity in the last war. It has since come to form the most important shell filling and is used either alone or in admixture with ammonium nitrate under the name of "amatol." T.N.T. melts at about 80° C. and is quite stable and

insensitive and is, therefore, quite innocuous, contrary to the popular conception about it.

Less in use but more powerful than T.N.T. as shell fillings are cyclotrimethylene trinitramine and pentaerythritol-tetranitrate. These two compounds have been taken into service in very recent times and are used either alone or in admixture with T.N.T. or some other ingredients.

Demolition Explosives

The requirements of explosives for demolition purposes are indeed heavy. Such explosives, besides blasting gelatines, include certain new types having as advantages improved performance, ease of handling and convenient portability. From this standpoint, gun-cotton is very satisfactory. It is used in the form of wet slabs primed with dry gun-cotton. Other explosives like T.N.T. and picric acid blocks with suitable primers have been taken into use. Besides, plastic high explosives have been evolved and are in considerable demand. A special type of high explosives are the aluminized explosives.

Pyrotechnic And Other Miscellaneous Compositions

Military pyrotechnics are modifications of fireworks designed to produce a brilliant light for illumination, or to produce coloured lights and smokes for signalling. With a few exceptions, pyrotechnic compositions are solid mixtures containing chlorates, nitrates, etc., to provide oxygen, combustible materials such as sulphur, antimony sulphide, metallic powders like magnesium and aluminium, and carbonaceous materials like charcoal, shellac, lactose, acaroid resin and the like, and salts of sodium, potassium, barium, calcium, strontium for colour.

Pyrotechnic compositions may be divided according to their use into (i) illuminating compositions, (ii) signal compositions, (iii) smoke compositions and (iv) incendiary compositions.

Physiological Effects

Most of the nitrogenous compounds being used as explosives have pronounced physiological effects. The headache that nitroglycerine causes is well known and is relieved by fresh air, and hot beverages. Some of the compounds are known to cause dermatitis or to affect liver.

Safety Precautions

If explosives are so terrific in their effects, as we know they are, the question arises as to how they are being manufactured without accident to life or property. Not that there are no accidents at all nowadays, but they are far fewer and more occasional than they used to be in the days of pioneers like Nobel and Abel, whose labours and sacrifice, we are beholden to them, have helped to reduce the risks involved in the manufacture and handling of explosives. Even so, in spite of all care, and one cannot be too careful in handling explosives, there have been terrible disasters, ending in untold loss to life and property. It is understandable, therefore, if the authorities concerned enforce rigorous regulations, sometimes to the chagrin of visitors, in premises manufacturing explosives and in magazines. For example, the manufacture and handling of nitroglycerine, one of the most sensitive explosives, is an art in itself, and very special precautions are observed in its manufacture and storing. Because of its extreme sensitiveness, nitroglycerine has to be consumed within the precincts of its production and is never transported free by rail or otherwise to distant places.

In storage and handling of finished explosives precautions are to be observed in strict accordance with set regulations. Either for transport or storage, explosives are officially classified into several distinct groups.

India's Contribution

So much has been said of explosives but what of India's contribution to this industry? Considerations of security preclude us for the present to talk on this question in all its aspects. There can be no doubt, however, of India's mighty contribution to munitions production as, in general, to the war effort. When the present war is over and its history written, one can be certain that India's rôle will find a prominent mention. In the interim it may be indicated that propellants, high explosives, plastic explosives and pyrotechnic compositions—some of them evolved here—are being produced in great quantities in India's different factories.

Salvage

There is little doubt that large quantities of explosives from indigenous manufacture and foreign supplies will be left over at the end of the war and how to utilize these locked-up stores of nitrogen is a first class problem for the powers-that-be in charge of the post-war reconstruction. Mixtures of T.N.T. and ammonium nitrate, principally in the form of amatols and ammonal, pure T.N.T., cordite and to a minor extent other propellants and demolition explosives are the major items for which an outlet will have to be found. It is on record that from the large stocks of amatols available at the end of the last war, ammonium nitrate was recovered by simple leaching with water and used as fertilizer. The same process for recovery and use may be adopted again in regard to ammonium nitrate. The question of utilization of military demolition explosives is also simple enough. At any rate, some of them are those normally employed for peaceful arts. It may not be difficult to convert cordite also into an industrial explosive. On the other hand, some investigation might be necessary to arrive at the best means of utilizing T.N.T. It is considered that this trinitro compound could serve very advantageously as a starting material for dyestuffs.

These are the immediate problems. There is the other greater and long-term problem, namely, of utilizing the ordnance factories in India to serve peace-time needs. It is already reported that the thousand factories and more, which His Majesty's Government in England established to meet the present emergency, will be handed over at the conclusion of hostilities to private enterprise with directive to manufacture therein the much-needed civilian goods in order of priority to be fixed upon. Post-war India possibly may have to adopt a similar policy.

It is also hoped that some of the ordnance factories in India could be harnessed for the production of industrial explosives such as are useful in peaceful arts like quarrying, tunnelling, road-making, construction of waterways, river dams, etc. Before the war India used to import such explosives to the tune of several millions of rupees annually. Out of the indigenous raw materials, it should not be difficult to manufacture India's entire needs of such explosives in her existing factories.

Whither Next?

The last word on explosives has not been said yet. Popular imagination readily accepts stories of new explosives discovered by belligerents, explosives of fabulous violence and with ruthless effect. Examination of even captured enemy ammunition shows that advances, as in the past, have been rather in the direction of improvements in the methods of applications of known explosives. Whether the enormous energy locked up in the atoms, which is yielding to the hammer blow of the cyclotron, is going to be harnessed at all, it is too early to say. One wishes it would not be, till the world is re-born, till a genuine respect for international comradeship and a uniform desire for common interests prevail.

After all, explosives have been more sinned against than the sinner. When the right sense of proportion is developed in man, the contribution of explosives in the service of humanity will be telling. It is no fault of explosives if men in their madness have misused them. It is no fault of the razor blade, if somebody, temporarily in a state of unsound mind, cuts his throat with it.—(*Published with the kind permission of the Director of Armaments (India).*)

ENGINEERING RESEARCH

IN the course of his Presidential address to the Eighth Annual Meeting of the Court of the Indian Institute of Science, Bangalore (2nd July 1945), Sir M. Visvesvaraya emphasized the importance of engineering research for the development of Indian industries. He observed: "The most urgent want in nation-

building in India, at the present time, is to make the large proportion of student population familiar with engineering research and with machine tools and machinery. To-day in education, mechanical engineering should be given a high place "

Reports from States and Provinces

Bengal

IN addition to the normal day-to-day activities of the Department of Industries, Bengal, some of which were mentioned in a previous note,* the following are a few noteworthy activities during the last few months :—

An attempt, at first on a modest scale, was made to develop salt manufacture on a cottage industry basis and thus meet the immediate needs of the province to some extent. Six salt warehouses were established in the coastal areas under the supervision and management of the Department of Industries. These having functioned successfully, their number was subsequently increased to twelve. 70,016 maunds of salt were collected and distributed under the scheme during 1944.

The prevailing paper scarcity has provided a great opportunity for reviving and establishing the almost moribund hand-made paper industry on a firm basis. Investigations undertaken by the Department to bring about improvements in the manufacturing process and to procure cheap and abundant sources of raw materials have proved successful. In recognition of the efforts in this behalf, the Government of Bengal in 1944 placed a revolving credit of Rs. 10,000 at the disposal of Dr. A. Karim, Director of Industries, Bengal. The amount was to be utilized for supplying raw materials in bulk price to professional *Kagazis* and for assisting them to market their finished products.

The Bengal Ceramic Institute which, as mentioned in the last note, was provided with a revolving credit of Rs. 30,000 is now working on a commercial basis and finished goods are being regularly produced and sold in the market.

As a part of the programme of popularizing technical training among the middle-class youth of Bengal, a number of scholarships are awarded annually by the Department. During the current year 38 such scholarships were made available for training in various branches of industry, viz., paints and varnishes, paper, plastics, textile weaving, leather and ceramic manufacture.

To help the poor silk rearers of Murshidabad District, and as a part of the scheme for the rehabilitation of the distressed artisans the Government of Bengal sanctioned Rs. 17,000. The amount was distributed among indigenous artisans through the S.D.O.'s concerned and with the help of the demonstration staff of the Sericulture Section of the Department of Industries. This measure will give a great fillip to the sericultural industry in the province.

(Contributed.)

Madras

Fishing Industry

The Administration Report of the Fisheries Department of the Government for 1943-44 states that deep sea fishing operations were initiated in July

1943, to increase the catches of shark and thus ensure an abundant supply of shark livers to the Government Oil Factory at Calicut. These operations now cover the whole Presidency. As a result of the investigations carried out during the year, five promising shark fishing grounds off the West Coast, and four off the East Coast were located. The total quantity of shark liver oil extracted in the fish curing yards and oil extraction centres, both in the East and West Coasts, was 6,805 gallons as against 3,575 gallons in the previous year.

The Government continued to maintain fish curing yards both on the East and West Coasts. There were 108 such yards at the end of the year. The total quantity of fresh fish brought to yards during the year was 22,23,728 maunds, salt issued was 3,40,890 maunds and cured fish removed was 15,31,217 maunds.

A scheme for the manufacture of smoked fish for supply to the civil population was sanctioned by the Government and 2,873 maunds of smoked fish were manufactured. A scheme for the manufacture of smoked fish for supply to the Army was also sanctioned. In order to ensure regular supplies of fish for smoking, they sanctioned the proposals of the Director of Industries to conduct in-shore fishing departmentally in two centres at Badagara and Telli-cherry. The scheme was not brought into operation in full before the close of the year.

The Government sanctioned the employment of a Special Officer for the development of fish manure industry. As a result of the work done by this Special Officer the dealers in fish oil, fish manure and fish guano have realized the advantage of converting all the available surplus quantities of various kinds of fish into guano and fish meal instead of turning them into crude manure of no particular commercial value. At the end of the year there were 51 fisheries schools on the West Coast with 7,659 pupils as against 59 last year.

For the development of the Inland Fisheries and for the greater exploitation of the sea fisheries two Fishery Development Boards of Departmental officers were formed during the year.

Kyanite Deposits in Nellore District

A report on Kyanite deposits in Chundi Estate, Nellore District, by Dr. B. C. Roy of the Geological Survey of India, is published in a recent issue of the *Fort St. George Gazette*.

Kyanite, according to the report, has found a growing use as an important refractory in ceramic industries in European countries. Normally, the Indian output is shipped to England, U.S.A., Germany, Belgium and Italy. It has only a very limited use in Indian ceramic industries. It is hoped that it will find a wider use in post-war industrial development.

Export of Feathers

In reply to a representation by the *Southern India Chamber of Commerce* in regard to the export of feathers, the Director of Commercial Intelligence, Calcutta, has passed to the *Chamber* certain suggestions received from British trading interests for the

* This *Journal*, 1945, 3, 427.

organization of collection and storage of feathers in India.

He says India possesses 18 per cent. of the world's duck population and that prior to the war there were large shipments from Britain of duck quills to India, especially to Sialkot City. It was deplorable that there was no organization for the collection of feathers in India when there was a great demand for them in England and for necks and skins of the grey Indian jungle-fowl. A special plumage licence is needed for its import into England for special purposes. In pre-war days the chief imports were from China. Indian trading interests were, therefore, exhorted to organize the feather trade as, in the course of the post-war period, there was likely to be a brisk trade in feathers.

United Provinces

The Power Alcohol Industry

At the initiative of Mr. E. de V. Moss, C. I. E., I.C.S., War Production Commissioner, U. P., a meeting of distillers was held (17th January 1945) at Lucknow. Representatives of the *Aluminium Plant and Vessel Company* were present by invitation.

Explaining the policy of the Government of the U. P., regarding the development of the alcohol industry, Mr. Moss said that the future of the industry lay in the economic production of industrial alcohol. The demand for potable spirits was not large enough and possibly could be met by a few distilleries which are already carrying on the work. Moreover, the future of the potable spirit industry was quite uncertain. Therefore, the alcohol industry should mainly concentrate on the production of motor fuel which has a rosy future.

In order that the production of industrial alcohol for use as motor fuel may be a success, the distilleries must work efficiently. The Government of the U. P. have decided to exercise the closest control of the alcohol industry with a view to ensure efficiency, and to this end they intend to appoint a technical expert to advise the Government.

As an essential feature of the close control of the industry, the future expansion of the distilleries will be controlled. For economy in production, every distillery should run throughout the whole year, i.e., about 300 days in the year. Sufficient raw material should be available with due regard to economy in transport, etc. Maximum efficiency of plants should also be ensured by permitting the setting up of only approved designs.

Mr. Moss then introduced to the meeting the two representatives of the *Aluminium Plant and Vessel Company Ltd.*, Mr. Lawless and Mr. Webb, who were requested to put forward their views.

Mr. Webb speaking for the *Company* explained his criterion of efficiency of a plant and stated that no efficient distillery should consume more than 8 lbs. of coal per gallon of alcohol produced. Any excess of coal consumption over this is a wasting asset, as the fuel value of alcohol thus produced will be less than the fuel used up as coal. He pleaded for improved methods of fermentation to achieve washes of higher alcohol concentration. The plants supplied by the *Aluminium Plant and Vessel Company* claimed low steam consumption. 35 lbs. of steam per gallon of absolute alcohol, using a 7 per cent. wash would be a fair "yardstick" of efficiency of a

plant. The minimum size of a plant should have a daily production of 2,000 gallons of spirit.

Mr. Raj Bans Bahadur, General Manager, *Daurala Sugar Works and Distillery*, pointed out that a close control of the distillery industry was essential in the interests of efficiency. He was of the opinion that the industry was already sufficiently controlled. If the plant manufacturing firms can assure them of more efficient and economic results, the business firms themselves would be eager to take advantage of the advice, even without pressure from Government. What is urgently needed is not more control measures but a definite assurance of a bright future for the fuel alcohol industry.

Mr. Bahadur further pointed out that while judging the efficiency of a plant by the steam consumed per gallon of alcohol, the approved standard must be very carefully laid having regard to the efficiency of the plants already working in the country. The data from these plants, especially those working on the principle of the 4th technique, like the plant at Hyderabad (Dn.), will prove very valuable in formulating the basis for judging the efficiency.

Mr. Raja Bans Bahadur also announced that his principals were interested in undertaking the fabrication of distillation plants and, therefore would like to be placed in the list of "approved" manufacturers. He also pointed out the importance of considering the views of the *Association of Distillers* which has already been formed.

Mr. Arnold pointed out the advisability of finishing distillation operations during the cane season which will eliminate the necessity of large storage tanks for molasses and coal in the off season.

The meeting concluded after a number of technical questions had been discussed.

Cochin

Possibilities of Glass Manufacture

A search for good glass-making sands in Cochin-Kanayanur taluk of Cochin State has led to the discovery of workable sand deposits at Eroor, Puthiyakavu, Nettur, Panangad and Palluruthi. The sand deposits of Eroor in Nadamel Village are found in four isolated tracts, Kodamkulangara Veli, Muthukulangara Veli, Mathoor Veli and Puthankulangara Veli. Large quantities of pure white sand are found at Puthiyakavu and Valanthuruthy in Tripunithura Tekkumbhagam Village and at Nettur, south of Ernakulam. The sand deposits of Panangad are almost continuous with those of Nettur, and it is quite possible that they form a continuation of the sand deposits of the Shertalai taluk of Travancore, separated from Panangad by the Kaithappuzha backwaters. The sand deposits of Palluruthi, south of Cochin, are mostly confined to the Veli near the Bhagavathi temple.

The only impurity in these sands is iron oxide in the form of magnetite grains. Ilmenite grains are also found in Palluruthi sand. Both magnetite and ilmenite can be easily removed from the sand either by electromagnetic separation or by gravitation methods. These impurities are also found in the Shertalai sand of Travancore, which is used for glass making in Alwaye. Mr. I. C. Chacko states in his *Geology of Travancore*, (1921): "The purest quartz sand is met within the taluks of Shertallay and Vaikom. Even in these taluks a small percentage

of ilmenite may be found, but, as has already been said, this impurity is not adherent to the quartz grains and may be mechanically separated off." The quartz grains in the sands above described are quite free from adherent and inherent impurities. These sands are quite suitable for glass manufacture, when they are washed and sifted.

Lime for glass manufacture is available in large quantities in the form of marine and backwater shells in this taluk. Several varieties of shells are washed ashore and can be collected from time to time. The chief varieties of shells found are : the oyster (*Ostrea virginiana*), the backwater clam (*Meretrix ovum*) and the black clam (*Velorita cochiniensis*). All these shells are largely used for the manufacture of lime.

Soda ash, manganese dioxide and other chemicals for glass manufacture have to be imported from outside. Coconut shells and firewood can be used as fuel and there is no scarcity for these materials.

There are not only prospects but also a distinct economic need for starting a glass factory in Cochin State. In Cochin-Kanayanur taluk, the two important raw materials, namely, sand and lime, are obtainable at cheap rates. There is no difficulty in getting fuel also, especially coconut shells. There are very good railway and shipping facilities, and the backwaters and canals afford a very cheap and easy means of communication. Labour is intelligent and plentiful, but skilled workmen from outside will have to be employed, at least, in the initial stages. (*Contributed.*)

Mysore

Pradhanasiromani N. Madhava Rau, Dewan of Mysore, briefly surveyed the recent industrial developments in the State, in the course of his opening address to the Representative Assembly (1st June 1945). He said: "A five-year programme comprising 28 works of irrigation, calculated to benefit 66,000 acres, had been drawn up at an estimated total cost of about Rs. 2 crores. Of these, seven projects had now been sanctioned and detailed estimates for the others were under preparation. The work of minor tank restoration had been receiving special attention : 304 works of restoration were in progress during the year. In co-operation with the *Imperial Council of Agricultural Research*, investigations were being made in improved methods of breeding pulses, groundnut and small millets. The manufacture of compost from town refuse was being carried on in 20 municipalities and a number of selected villages. It is expected that this work would be started in

another 12 centres shortly. The investigation of sheep and goat diseases has been undertaken in co-operation with the *Imperial Council of Agricultural Research*. A token provision of Rs. 1 lakh had been made in the budget for the coming year for schemes of development of live-stock which were under consideration. It is proposed to start a training centre for veterinary stock-men.

Dealing with sericulture industry in the State, the Dewan said the development of sericulture achieved under the stimulus of war-time conditions might well be a permanent feature of the economy of the State. Necessary steps were, therefore, being taken to consolidate the progress made and to place the industry on a sound basis.

Regarding the progress of the Jog Hydro-Electric Works, in spite of various difficulties and setbacks which were to be expected in carrying out large projects of this character, very good progress had been made on the construction of the Jog Hydro-Electric Works. The outlay on civil works was about Rs. 179 lakhs against a provision of Rs. 264 lakhs in the revised estimate. The Karagal anicut, the forebay and the materials track had been completed and work on the main dam and the power canal and the erection of penstocks was progressing satisfactorily. Part of the machinery had arrived and erection work would commence as soon as the building for the generating station was ready.

Mining and washing of kaolin at Bageshpura was proceeding on a fairly large scale. Underground exploration for gold from the auriferous reefs at Bellara in Tumkur District had been undertaken and the old workings were being reopened. Further investigations would be made to ascertain the quality of asbestos from deposits in the Hole-Narsipur area with a view to starting the manufacture of asbestos cement products. The possibility of manufacturing rustless steel was being examined. It was hoped to make a beginning shortly with the manufacture of radio receiving sets. A company under formation had applied for facilities for starting an alkali industry in the State. The erection of strip and rod mills at the *Mysore Iron and Steel Works* had been completed and the steel foundry was being extended at a cost of about Rs. 2½ lakhs. The question of installation of an electric pig-iron furnace at Bhadravati was being actively pursued and a token grant of Rs. 4 lakhs was proposed for this purpose in the budget for the coming year. Preliminary surveys were being made for the expansion of the cement plant and the extension of the tramways and ropeways.

Notes and News

Anion Exchange Resins and Metal Recovery

A NEW process for recovering valuable and essential metals was announced by the chemists of the *Permutit Company* of New York at the eleventh annual chemical engineering symposium. Chromium, vanadium, molybdenum, gold, platinum and other metals may be recovered from waste solutions by absorption on anion exchange resins under certain conditions.

Primarily intended for the recovery of metals now being lost in waste waters, the new method is also expected to be beneficial in reducing stream and harbour pollution in the vicinity of electro-plating and other metal-working plants. Under special conditions, anion exchange resins will completely absorb metal salts from very dilute solutions. When complete absorption is no longer obtained, the resins are treated with appropriate chemical solutions to effect recovery of the metals in the solutions which may be 25 or 30 times as concentrated as in the original waste liquors. The anion exchange resins undergo no permanent change in the process and may be reused indefinitely. (*Chem. Age*, 1945, 52, 313).

In contrast to many previously proposed processes for the recovery of metals of this group, the new anion exchange process provides the recovered metal in the form of a salt which may be used directly in plating or other processes. Precious metals may be recovered more economically by the simpler alternative process of incinerating the resin after saturation with the metal, and as the anion exchange resins are almost entirely free from ash-forming impurities, the residue consists practically of the pure metal.

A Selective Weed Killer

Large-scale field trials carried out during 1943 and 1944 by the *Imperial Chemical Industries* and the *Agricultural Research Council* in the U.K., have established the value of *methoxone* as an effective weed killer. It was shown as early as in 1940, that *methoxone* functioned as a selective weed killer. It was later established that all plant hormones had this property. *Methoxone* was selected as the most useful for agricultural purposes and large-scale trials were undertaken. *Chloroxone*, another weed killer designated *D.C.P.*, was being experimented with in the U.S.A. Their comparative efficiencies were tested on a large scale in the U.K. and *methoxone* was shown to be by far more effective. (*C.T.J.*, 1945, 116, 341).

Used in a dosage of 1 lb. per acre, many common weeds, e.g., yellow charlock, wild radish, corn buttercup and pennycress, are destroyed; the crops are unaffected. The destruction of weeds in early stages reduces aggressive competition for soil nutrients and better crops and better yields are secured. This is a revolutionary development in practical farming, well established on a scientific basis.

Standardization of Trichromatic Inks

The standardization of the colours of inks used in three-colour printing is of special importance. A joint committee of the *Federation of Master Printers*, the *Federation of Master Process Engravers* and the

Society of British Printing Ink Makers made an attempt in 1929 to standardize the printers inks and agreed on the so-called *British Standard Trichromatic Inks*, for all normal three-colour printing work. No attempt was made, however, to define the colours of the inks scientifically, as it was not considered practicable at that time. The standards were issued as half-tone wedges together with two-colour illustrations printed in a four-page booklet. Prints of half-tone wedges were also published as the "British Standard Trichromatic Inks—Set of Master Hues." A gradual drift from the standards was discernible and indeed it was found that if orders for British Standard Inks were placed with different makers distinctly different inks were obtained.

In a well-illustrated article Harrison, (*Patra*, 1945, 8, 69) discusses the advantages and disadvantages of standard inks. A critical examination of the laws of colour mixture leads him to the important conclusion that, the question of standardizing the trichromatic inks appears to have two distinct aspects. One may be required to reproduce a given copy as faithfully as possible, in which case, if it has any bright colours it may be advantageous to use inks which depart from normal in one direction or another. For such work, the chance of standardization is remote and would probably serve little useful purpose. If a printer can get a more faithful reproduction by using an exceptionally green shade of blue for a blue printer, he will probably use that shade. On the other hand, there are cases where one has to print from a number of blocks and there is no possibility of being able to get the finest possible results from each block individually; all that is practicable is to get the best mean overall results from all the blocks mounted together. In such cases it is usually best to distribute the errors throughout the blocks as evenly as possible, and to this end the adoption of a standard set of trichromatic inks would be helpful. It is strongly urged, however, that if such standards are decided upon, they should be standardized properly—that is, by scientific means, because only by scientific means can we be sure that the standards will not change with time and will not give variable or ambiguous results.

Standards that prove in practice to be variable or untrustworthy are soon discredited and they tend to shake the faith of the user in standardization and measurement generally.

Industrial application of Rare Earth Metals

The impetus to the study of the 14 closely allied rare earth metals has come mainly from the ceramic industry. The ability of these metals to absorb ultraviolet rays has been taken advantage of in the manufacture of welding goggles. Cerium and didymium salts, in a concentration of 2-4 per cent. Ce_2O_3 , renders glass completely absorbent to ultraviolet. The irradiation properties of cerium have been utilized, to some extent, in fluorescent tubes with mercury vapour lamps. The rare earth metals are also used for colouring and decolourizing glasses. Neodymium gives the only bright purple colour available. A combination of cerium and neodymium is used in artificial gems, especially rubies. Cerium dioxide can be substituted for tin dioxide in opacifying enamels but it is too expensive for general use.

In the metal industry, cerium is the most widely used. As it is pyrophoric, cerium is applied for lighter flints and tracer shells. Cerium as misch metal is a very active getter for gases in electronic vacuum tubes. Cerium in case iron whitens the structure, while in steel it increases the hardenability to a certain extent and has a grain refining action. It is particularly used in alloys for heating elements. At high temperatures, cerium increases the solubility of hydrogen in aluminium. Cerium additions to *Avional* and *Aldrey* decrease the tensile strength and increase the electrical conductivity. In magnesium, cerium increases the ductility and strength. Praseodymium in general forms very hard and brittle compounds in alloys.

The main application of the rare earths in the chemical industry is as catalysts in the organic field. Cerium fluoride in carbon pencils for arc lamps increases the brilliance of the light.

Biologically, these metals have an irritant effect on the nervous system when inhaled. Erbium and cerium salts have better anti-anæmic properties than iron, but their adoption for this purpose is not promising, as they are relatively poisonous and increase blood coagulation. Cerium iodide inhibits cancerous tissues, while cerium oxalate is occasionally used for sea sickness. In general, the rare earth salts have an antiseptic, tonic and astringent action in the human body; in horticulture, they increase the yield of fruit.

In textiles, the rare earth salts are used with tin salts to delustrate rayon, weight silk, increase the light-fastness of dyes and in mordanting.

U.S.O.W.I., Min. & Met. Eng. Newsletter No. 9, 1945.

Spinning Quality and Chemical Characters of Jute Fibre

The results of an investigation on the relationship between spinning quality and chemical composition of jute fibre, undertaken by the Technological Research Laboratories of the *Indian Central Jute Committee*, are described in the *Technological Research Memoir No. 6* of the Committee recently published. It is shown that analytical data may be of use in combination with physical measurements on the fibre, in assessing the fibre quality of jute. The importance of this lies in the possibility of assessing spinning quality by an examination of quite small samples, which is extremely useful in connection with breeding trials and agricultural experiments generally.

Microscopical examination of yarn shows that quality is associated with the length of the ultimate fibres.

Preliminary studies of the periderm, or outer bark, of eight *capsularies* types indicate that the roots of the jute plant, which are harmful for the fibre, can be eliminated, at least to some extent, by properly timing the harvesting of the crop. The periderm increases in extent long after vertical growth of the plant has ceased.

Control of Bamboo Borers

A new method for the protection of hollow culms in bamboos with internodal injection of creosote and fuel oil, and another for impregnation of hollow culms with solutions of inorganic salts, etc., are among the various protective methods described in a bulletin entitled *A Note on the Insect Borers of Bamboos and Their Control*, published by the Forest Research Institute, Dehra Dun.

With the enormous demand for bamboos, their protection against insect borers has assumed great importance, as serious losses have been caused by borers. The bulletin summarizes information on the control of the insect borers with special reference to *Bostrichidae* (known as *Ghoon*), the most important family of parasites.

The two new methods which have been developed at the Institute have been found entirely satisfactory both in efficacy and practicability, and one of them (the internodal injection method) was adopted as the standard by the Ordnance Department for large-scale work.

Compregnated Wood

That compregnated wood of good strength and possessing other favourable properties can be produced from inferior Indian timbers has been shown by investigations carried out at the Forest Research Institute, Dehra Dun (Indian Forest Leaflet No. 77).

The leaflet describes the results of tests on the strength and other properties of improved wood produced by lamination and compression.

The uses of the material are varied and many; they range from aircraft propellers to textile mill accessories and for the needs of the electrical and chemical industries. Materials prepared at Dehra Dun have been tested with encouraging results for aircraft propellers, river barge bearings, tube well buckets, shuttles and fish plates for electrified sections of main line railways.

Leather Preservatives

A study of dubbing carrying preservatives for the protection of leather against molds and mildew has been recently undertaken, according to a report in the *American Leather Chemists' Association*. By virtue of being a chrome retan leather of high grease content with, consequently, a lowered water absorption, army shoe-upper leather is relatively resistant to mold growth. Grain-finished leather is usually more resistant than flesh-finished leather. *p*-nitrophenol, *p*-chloro-*m*-xylenol, penta-chloro-phenol and tetra-chloro-phenol have proved very effective when used in dubbings. A mixture containing equal percentages of *p*-nitrophenol, *p*-chloro-*m*-xylenol and tetra-chloro-phenol is recommended. It has protected grain-out leather under test conditions for periods longer than nine weeks, and flesh-out leather under the same conditions for five weeks. Penta-chloro-phenol is recommended as a substitute if *p*-chloro-*m*-xylenol is unavailable.—*U.S.O.W.I., Chem. Eng. and Chem. Newsletter, No. 9, 1945.*

Manufacture of Locomotives

The E. I. Railway Workshops at Singhbhum have been transferred from the Indian State Railways to Tatas for the manufacture of boilers and locomotives. This is described as a landmark in the history not only of Indian railways, but of Indian industry, and the beginning of a planned enterprise, on a commercial scale, for establishing in the country an industry to which Indian public opinion has attached great importance.

The first boilers are expected to come out of the Singhbhum Workshops by the end of the year. The manufacture of boilers is to be followed as soon as possible by the manufacture of locomotives. Government will buy a guaranteed number of boilers

and locomotives from Tatas, and if the company is able to produce more Government will purchase such additional production in preference to imports.

Government are obtaining for the project more than Rs. 30 lakhs worth of machinery, mostly from the United Kingdom, on very high priorities.

In a message to Tatas on the occasion of the formal handing over of the Singhbhum Workshops, the Chief Commissioner of Railways expressed his confidence that these works will before long occupy a high and honoured place in the industrial organization of the country. He offered the best wishes of the Indian Railways for the success of the venture.

Oil in China

Oil has been discovered in the north-west of China, according to a despatch from Reuter's special correspondent in Chungking. The deposits are said to be so large, that the petroleum industry may become one of the biggest industries of China. Specific figures on the extent of the deposits are not yet available.

Oil is now being produced in the province of Kansu, and also in Manchuria. China is able to produce more than she can refine, and refine more than she can transport. It is understood that the *National Resources Commission* is contemplating the laying of a pipeline from Yumen, oil-producing centre in the Kansu Province, to Kwangyuan, an important communications point, 465 miles north-west of Chungking, from where it can be transported by boats to Chungking. In view of the shortage of materials, the projected pipeline will have to be completed by stages.

Bengal Immunity Company Silver Jubilee Celebration

The *Bengal Immunity Co., Ltd.*, celebrated the Silver Jubilee of its foundation with fitting pomp on 10th May 1945, in Baranagar, Calcutta. The illustrated souvenir which was issued on the occasion sets out briefly the origin, growth, development and scientific activities of the great organization. Sir Hari Shankar Paul, Chairman of the Board of Directors, in the course of his Presidential Address, narrated how "starting with an extremely humble beginning, and forging ahead with confidence and complete grasp of the problems before it, the Bengal Immunity Co., Ltd., has shown to the world what determination, foresight and honest and unswerving pursuit of an idea can achieve. I must confess that at the inception of the Company 25 years ago, there were many amongst us who entertained great doubts about its being able to fulfil its great destiny and to fully realize the immense possibilities before it. They held that organizations brought into being under stress and strain of abnormal times and circumstances were most likely to fall off with the subsiding of the strain, and the definite and gradual lessening of the force of necessity that was responsible for their inception. The Bengal Immunity Co. is fast moving to fulfil its great destiny and by its startling achievements and its feverish activities towards further extension, it has nailed to the counter all such doubts and fears."

Dr. U. P. Basu, Chief Chemist, gave an account of the research activities of the Company. The production and manufacture of medicaments is not, and should not be, the main objective of the drug industry. The development of new ideas, improvement in the quality of drugs and introduction of fresh

features in medicaments, are equally important for a progressive industry. Research and development through which progress is possible, thrive only on the basis of co-ordinated team work of all the workers engaged in the organization.

Sir J. C. Ghosh who was the chief guest during the festivities, went round the research and testing laboratories of the Company. He expressed appreciation of the work carried out by the scientific staff under the inspiring guidance of the Managing Director, Captain N. N. Dutta. In the course of his address, Sir J. C. Ghosh referred to his recent visit to the United Kingdom, the United States of America and Canada, and the progress of science and industry in those countries. "War has done one good thing," he said, "it has made the common man science-conscious." It has shown that to neglect research is to invite calamity. An industry based on scientific discovery and invention has little chance of survival in a competitive world unless it is backed up by continuous research and new inventions. Research is considered to be the elixir of life of industry in England. The industry is ever kept young and vigorous. The Managing Director of Bengal Immunity Co., by earmarking 25 per cent. of the net profit for the welfare of the employees, and another 25 per cent. for the prosecution of research, has fallen in line with the most enlightened business executives in England and America. Sir J. C. Ghosh expressed the wish that Capt. Dutta may be spared long in the service of the Bengal Immunity Company so that the concern may grow better, bigger and more efficient, and that it may present to the people of India a glorious record of his stewardship in the year of its Golden Jubilee, in 1970.

A Central Film Academy and Research Laboratory for India

The Committee of the *Independent Film Producers' Association*, at its meeting held in Bombay on 26th March, resolved that a central institute should be established in India for training the technical talent required to develop the film industry in India. The Committee also urged the establishment of a research laboratory for undertaking investigations relating to the manufacture of raw films, technical machinery and other accessories. A fact-finding committee was appointed to collect information relating to these developments with Sir Homi Mehta as Chairman.

It may be stated here that India is the third film producing country in the world, the first and second being the United States of America and Japan. Among the industries, the film industry occupies the eighth place in India. The number of pictures produced annually in India is about 150. There are nearly 1,700 cinema houses including 4,000 travelling cinemas. Considering the population of India, the number of cinema houses is very small indeed. There are 19,000 theatres in the U.S.A. (population, 122 millions) and 5,000 in the United Kingdom (population, 47 millions). The scope for the development of the film industry in India is very large. The entire bulk of raw films and sensitizing materials, valued at about Rs. 60 lakhs, is imported into this country. The industry pays Rs. 14 crores to the Central Exchequer in the form of import duties on raw films and machinery and entertainment and other taxes imposed by Central and Provincial Governments.

The central institute will impart technical training in the various branches of the industry—from scenario writing to the projection of films. The delegation of

the film industry which will be visiting the United Kingdom and the United States of America shortly, will discuss the problems of the industry with specialists in the two countries and obtain such information as will be of value in the establishment of the central institute and the research laboratory.

The following sub-committees have been set up :

1. *Chemicals* (Raw films, sensitizing dyes, photographic chemicals, etc.) : Dr. K. Venkataraman, Dr. K. A. Hamid, Dr. D. R. Nanji, Mr. Kapilram H. Vakil, Dr. J. V. Karandikar, Prof. M. Q. Doja, Mr. S. Balkrishnan and Mr. K. S. Hirlekar (Convener).

2. *Instruments and Machinery* (Optical lenses, instruments, cameras, projectors, accessories, etc.) : Prof. Meghnad Saha, Principal G. R. Paranjpe, Prof. K. S. Krishnan, Dr. Nazir Ahmad, Prof. B. B. Deshpande, Mr. M. A. Fazalbhoy, Mr. Jagannath Patel and Mr. K. S. Hirlekar (Convener).

3. *Motion Picture Technique* (Central Training Institute, curriculum, etc.) : Mr. Chandulal J. Shah, Mr. B. M. Shaw, Dr. M. D. Manohar, Mr. Krishna Gopal, Prof. B. B. Deshpande, Mr. Kumarsen Samarth, Mr. K. D. Multani and Mr. K. S. Hirlekar (Convener).

The sub-committees have commenced their work. They have appointed smaller sub-committees to collect, catalogue and review available data and to report to the sub-committees concerned.

U.S. Post-war Waterway Projects

With the approval of the \$1,000,000,000 Flood Control Bill on 22nd December 1944, the potential backlog for river and harbour, flood control, and multiple-purpose projects that have been adopted by the U.S. Congress was increased to about \$3,000,000,000. This programme is composed of suspended projects that can be resumed whenever conditions permit, of new projects that have never been initiated, and of projects required to complete approved comprehensive basin plans for which additional money authorizations will be necessary. Supplementing this authorized programme the estimated dollar volume of projects that are contained in the post-war River and Harbour Bill now pending before Congress, plus flood control and river and harbour projects that have been favourably recommended to Congress but on which action has not yet been taken, increases the overall potential post-war programme for waterway improvements to approximately \$4,500,000,000.

Of the total programme authorized by Congress, detailed construction plans and specifications for a wide variety of work estimated to cost \$500,000,000 and distributed throughout the country are ready. The amount of work in this advanced stage of readiness is being increased rapidly, consistent with the prosecution of military work. It is expected that the volume of work ready for contract will reach a total of \$731,000,000 by late summer of 1945. The public works covered by this authorized programme, practically all of which will be performed by contract, include a wide variety of structures and types of construction. The numerous approved reservoir projects will involve rolled earth, rock-fill and concrete dams varying from small structures for flood detention only, to extremely large ones for multiple-purpose projects. Power installations will be provided at some dams and at others provision will be made for power development in the future. The corresponding range in estimated costs of these dams and reservoirs will be from several hundred thousand dollars to well over \$100,000,000. The local protection projects will

involve earth levees, concrete walls, pumping stations, channel improvements and diversions, while navigation projects will include locks, dams, canals, river improvement and corrective dredging, channel stabilization works, breakwaters and jetties. Considering, in addition, the highway and railway relocations necessary for reservoir construction it is obvious that practically every type of construction work is represented in the programme. The primary purposes of the works are navigation improvement and flood control, but irrigation, power development, abatement of pollution, improvement of recreational facilities, establishment of wild life preserves and other corollary benefits are included wherever practicable.—*U.S.O.W.I., Civil Engineering News letter No. 7, 1945.*

Post-war Construction and Engineering Work in Brazil

The Research Division of the Office of Inter-American Affairs in New York City has completed recently a study of potential industrial developments in Brazil, which indicates that a large volume of engineering and construction work will, in all probability, be undertaken in the early post-war years. The Co-ordinator of Economic Mobilization recently stated that plans for the industrial development of Brazil would require at least \$2,500,000,000 and possibly \$4,000,000,000 within the next decade. Proposed plans include a more complete utilization of the hydro-electric potential of 20,000,000 h.p. (at present only 7 per cent. has been developed) : completion of a coastal system of railroads from the Uruguayan border to Belem and a secondary system to connect coastal with interior railroads ; a highway network programme ; further expansion of the iron and steel industry ; mechanization of agriculture, using modern techniques and equipment ; and extensive public works programme and development of mining and metallurgy. Expansion in the production facilities for textiles, cement, chemicals, glass, paper, electric equipment, food processing, aircraft, rubber and a variety of consumer goods is also contemplated.

Although many of these projects are in the blueprint stage, others have already been initiated, orders placed and construction started. With steel as a foundation, Brazil is developing a programme of industrialization designed to revolutionize its economy. The steel mill project at Volta Redonda, costing \$75,000,000, is nearing completion and will utilize high-grade ores from Bellow Horizonte. It is estimated that this plant will be capable of producing 750,000 tons of steel annually. Brazil has 25 per cent. of the known iron ore reserve of the world. Possible development of new plant facilities in Brazil will require machinery and equipment with an estimated value of \$300,000,000, and the replacement of depreciated and obsolete equipment will likely require an additional \$700,000,000.—*U.S.O.W.I., Civil Engineering News-letter, No. 8, 1945.*

Department of Fisheries, Bombay

A separate Department of Fisheries has been constituted by the Government of Bombay to replace the existing Fisheries Section of the Department of Industries. The new Department which is being set up on a temporary basis for five years, will be under the control of a Director of Fisheries. He will have under him four Superintendents—one each for Marine, Inland Technology and Coast—five Assistant Superintendents, four Research Assistants and a Laboratory Assistant.

Indian Institute of Science

The services of three British experts have been secured, on loan for three years, to enable the expansion of the Department of Aeronautical Engineering. The Department which was started in 1942, will be greatly expanded and reorganized to meet the demand for a large number of trained specialists.

New Departments for Metallurgy, Internal Combustion Engines, and High Voltage Engineering will be opened shortly. Considerable expansion in the activities of the Institute have taken place during the past four years, and further developments in High Pressure Engineering, Fermentation Technology and Food Technology are being planned.

Indian Industrialists in U.K.

The Indian industrialists who are on a visit to the U.K. and U.S.A. to acquaint themselves with the war-time developments in the industrial and technological fields completed the first stage of their itinerary and have left for America. Like the scientists who preceded them last year, the industrialists have acknowledged the friendliness and cordiality with which they were received everywhere. The *Association of British Chambers of Commerce* and the *Federation of British Industries* had made necessary arrangements for their tours and for facilitating business contacts desired by the industrialists. They toured extensively all over the country, addressed press conferences, and discussed problems of capital equipment, technical assistance, and related problems with leaders of British industry and finance. The industrialists found that there was a growing realization among the British industrialists "that India must and will develop industrially and economically thereby becoming a bigger potential market." There is a growing feeling that nothing must prevent the industrialization of India. If India's industrialization is not to take an intolerably long time, India will have to rely on imported capital goods and foreign technical help. In obtaining these requirements, limits are set neither by the goodwill among British manufacturers nor by finance, but by the availability of plant and machinery, and of technical personnel. India can expect to get no more than a fair share of the limited output of the capital goods in the next year or two.

Summer Lac Crop

Baisaki Estimates—"Preliminary estimates for this year's *Baisaki* lac-crop for the whole of India stands at about 75 per cent. of the previous five

years' average," states the report of the Crop Statistician, *Indian Lac Cess Committee*. This estimated decrease can be explained as due to scarcity of *Katki* brood-lac, which serves as seed for the *Baisaki* crop. The infection of the host-trees of lac could not be carried out satisfactorily with the result that many host-trees were left uninfected.

The final yield of the crop depends mainly on the climatic conditions in April-May. With favourable climatic conditions, the yield of the crop may be somewhat greater than the present estimate. It is as yet too early to estimate quantitatively, *Jethna*, the other summer lac-crop.

Announcements

Birthday Honours.—The following awards, among others, have been gazetted:—

C.I.E.:—Mr. R. S. Simons, Joint Secretary to the Government of India in the Finance Department; Member of the Governing Body, Council of Scientific and Industrial Research, Delhi.

Rai Bahadur:—Dr. R. B. Dey, I.E.S., Director of Public Instruction (Officiating), Madras.

Indian Chemical Society: J. M. Das-Gupta Memorial Medal.—Applications are invited for the award for 1944 from Research Chemists of any age. The award will be made on unpublished researches and/or on independent papers published in the *Journal of the Indian Chemical Society* by the candidates during the years 1943 and 1944. Applications together with four copies of each reprint or typewritten paper, should reach the Hon. Secretary, Indian Chemical Society, 92, Upper Circular Road, Calcutta, *not later than 30th September 1945*.

Mr. D. N. Wadia, Mineral Adviser to the Government of India, Department of Planning and Development, has been nominated a member of the Board of Scientific and Industrial Research.

Dr. Atmaram has been appointed Officer-in-charge of the Central Glass and Silicate Research Institute, Calcutta.

Dr. G. P. Contractor has been appointed Assistant Director (Planning), National Metallurgical Laboratory.

National Physical Laboratory.—The National Physical Laboratory of the Council of Scientific and Industrial Research will be located in Delhi. The decision was taken by the Governing Body of the Council at its meeting held in New Delhi on 18th March.

Indian Patents

[The following is a list of Patent Applications notified as accepted in the *Gazette of India, Part II—Section I*, for the period April–May 1945. Patents from the *Council of Scientific and Industrial Research* are indicated by an asterisk.*]

30782. PERMANENT MAGNET STRUCTURES: *Flux leakage path and armature section built of series of strips of soft iron separated by non-magnetic material and means for moving armature end-wise.*—S. I. Hitchcock.
30784. CLUTCH AND THROTTLE CONTROL DEVICES: *Means connecting them to clutch and throttle and interlocking means between said connecting means.*—Ford Motor Company of Canada, Limited.
30785. PERMANENT OR ELECTROMAGNET MOTOR OR GENERATOR STRUCTURES: *Flux leakage path formed of members of soft iron broken by air gap member of non-magnetic material.*—S. I. Hitchcock.
31129. PRODUCTION OF H_2S GAS: *A tube having perforations at the bottom is fitted to a cylinder having holes at the bottom and placed inside an outer cylinder.*—K. C. Nijhawan.
31251. HOLDER FOR SHAVING STICK: *Case with a detachable cap the soap inside being held by small projection on the inside of the case.*—M. M. D. Joshi.
31281. SPINNING TOYS: *Emitting musical notes during rotation.*—M. M. D. Joshi.
31477. TREATMENT OF SEEDS AND TUBERS with preparation containing chloronitrophenols.—I. C. I. Ltd.
- * 31594. ANTHRAQUINONE VAT DYE STUFFS: *Fusing benzathrone with aqueous caustic soda.*—V. V. Gokhale and K. Venkataraman.
31651. IMPROVEMENTS IN RADIO RECEIVERS FOR DIRECTION FINDING: *Plurality of antenna having different directional properties and cathode ray tube for giving indication of bearing.*—Radio Transmission Equipment, Limited.
31761. A SPONGE-HEAD BRUSH: *Spongy rubber head fixed to convenient handle.*—J. V. Roy.
31845. ELECTRIC DISTRIBUTION BOARD has pairs of contacts arranged in horizontal rows, one above the other and bridged by fuses, upper contacts connected to cables and lower ones to horizontal busbars.—W. T. Henley's Telegraph Works Company Limited.
30760. HYDRAULIC WORK HOLDERS: *Supporting body, work engaging collet, and reciprocable plunger.*—J. T. Obecný.
30765. HEAT TREATMENT OF METAL WIRE, STRIP AND THE LIKE: *Metal material having electric connection by means of baths of molten metal, one of which is used for quenching the heated metal.*—W. H. Wood and another.
30790. ACTIVATION OF BENTONITE CLAYS: *Treating with sulphuric acid.*—Standard Oil Dev. Co.
30852. REFINING IMPURE IRON: *Refining iron by melting it in cupola furnace in the presence of basic slagging materials.*—Ford Motor Co., of Canada Ltd.
30880. SUCTION CLEANERS: *Main nozzle, nozzle for removing dirt from filter, and means including pressure responsive device for automatically actuating filter cleaning nozzle.*—Hoover Ltd.
30881. SUCTION CLEANERS: *Initial dirt separator, motor-driven fan, second separator or filter, movable filter-cleaning nozzle and driving connection including speed-reduction gear.*—Hoover Ltd.
30882. SUCTION CLEANERS: *Casing main nozzle, dirt filter, filter cleaning nozzle and means for moving filter cleaning nozzle.*—Hoover Ltd.
30883. SUCTION CLEANERS: *Fan, dirt separator of vortex type and removable dirt container.*—Hoover Ltd.
30884. SUCTION CLEANERS: *Motor-driven fan, filter, filter-cleaning nozzle and mechanism for moving the nozzle relatively to the filter.*—Hoover Ltd.
30885. SUCTION CLEANERS: *Initial separator including rotary separating element, fan, final separator and movable nozzle.*—Hoover Ltd.
30941. CARDING ENGINES: *Cleaning action in the taker-in region comprising a control member and a collecting member.*—The British Cotton Industry Research Assn.
30949. POWER TRANSMISSION MECHANISM: *Input and output shafts with gears and pressure oil-operated couplings or brakes compactly housed in a gear-box.*—T. Hindmarch.
30953. MEDICINAL PREPARATIONS CONTAINING SULPHONAMIDES: *Preparation containing sulphonamides, alkylolamine and a cellulose derivative.*—American Cyanamid Co.
30994. APPARATUS FOR TESTING GYROSCOPIC AND LIKE INSTRUMENTS: *Rotating and rocking means operated by same motor.*—G. H. Reid.
31151. HOLLOW RUBBER ARTICLES: *Spreading rubber compound on former made from clay, vulcanizing and thereafter washing out the clay.*—R. B. S. Jain Rubber Mills.
31163. ALTERING THE SURFACE HARDNESS OF HOLLOW METALLIC MEMBERS: *Making the metallic member one element of a concentric line and passing high frequency current through said line.*—R. C. A.
31193. IMPROVING THE WHITENESS OF MATERIALS: *Treating with blue-fluorescent substance and of a blueing agent.*—Lever Bros. and another.
31195. TELESCOPIC FIREARM: *Two inter-telescopic member capable of being locked in position or instantaneously released.*—G. W. Patchett and another.
31196. FOLDING BAYONET: *Means for instantly releasing the bayonet and locking it in operating position.*—G. W. Patchett and another.
31319. BENEFICIATION OF OXIDIZED IRON ORES BY FROTH FLOTATION: *In presence of water soluble petroleum sulphonate.*—American Cyanamid Co.
31342. PREPARATION OF 2-AMINOTHIAZOLE: *Treating chlorinated alcohol with thiourea.*—Haffkine Institute.
31387. ELECTRIC ARC WELDING: *Uniting two plates by spot weld penetrating through upper plate.*—Murex Welding Processes Ltd.
31476. AIR DRYING AND STOVING FINISHES: *Heating varnish to 280°C. and passing inert gas.*—I. C. I.

31478. INSULATORS FOR HIGH TENSION ELECTRICAL TRANSMISSION SYSTEMS: *Fastening member of insulators provided with metal projections.*—Steatite and Porcelain Products Ltd.
31579. PISTONS FOR INTERNAL COMBUSTION ENGINES: *A spring ring arranged and shoulders provided for facilitating the securing of the insert ring to the piston.*—Specialloid Ltd.
31580. PHENANTHRIDINIUM COMPOUNDS: *Converting amino phenanthridinium salts into carbalkoxy-amido or other carbaxyamido hester group.*—L. P. Walls.
31629. LARVICIDES: *Plant known as Akalkara or Akalkadha is extracted with an organic solvent and the solvent evaporated.*—G. S. Pendse and another.
31732. MAGNETIC ARTICLES: *Composed of an alloy of iron and cobalt.*—Standard Telephones and Cables Ltd.
31802. LIQUID FUEL STOVES: *Annulus burner head having across tube with upper and lower flame orifices.*—E. D. O. Bernier.
31810. JIGS AND FIXTURES: *Built up of a plurality of interchangeable standard elements assembled and secured together by interlocking, and secured to a machine.*—W. Wharton and another.
31915. ELECTRICAL PLUGS: *Contacts pins of an electrical plug screwed into holes in the terminals springs between terminals and pins screw as contacts and lock washers.*—Dorman & Smith, Ltd. and another.
31938. CARBON PILE: *Regulator with means for testing the pressure applied on the carbon pile by the control spring.*—J. Stone & Co., Ltd.
31948. LACQUERS: *A solution containing ethyl cellulose, transformer oil, petroleum jelly and castor oil.*—British Insulated Cables Ltd.
30457. WATERPROOF FIBROUS COMPOSITIONS: *Coating fibrous sheet with bitumen or tar-pitch and passing the said sheet through a cool waterbath.*—C. M. Baskin.
30459. WATERPROOF FIBROUS COMPOSITIONS. *Fibrous material is coated with bitumen a tar-pitch and passed through pulverized material.*—C. M. Baskin.
30519. TELEGRAPHIC COMMUNICATION SUPER-IMPOSED ON A TELEPHONE SYSTEM: *Electric discharge relay connected in circuit instead of usual noise telegraphic relay.*—Captain M. S. Visvanathan.
30853. SILICON IRON ALLOY FOR ELECTRICAL USES: *Casting silicon iron alloy into slabs or sheet bars and then rolling.*—Joseph Sankey & Sons Ltd.
30863. FLUID FLOW REGULATING MEANS, SUCH AS FOR REGULATING THE DISTRIBUTION OF LUBRICATING OIL TO ONE OR MORE BEARINGS: *Holder enclosing a mass made from porous substance inserted into the conduit providing plurality of passages of relatively five proportion.*—Tecalmit Limited.
30873. TREATING WATER TO PREVENT FOAM GENERATION IN STEAM GENERATORS: *Water containing a very small amount of acylated diamines or polyamines.*—I.C.I. Ltd.
30874. TREATING WATER TO PREVENT FOAM GENERATION IN STEAM GENERATORS: *Adding in water one or more substances having two n-substituted amide group.*—I.C.I. Ltd.
30912. APPLYING COLOUR ON GLASS WARE: *Spraying colouring chemical suspended in turpentine on the surface and then firing.*—J. P. Gupta.
30916. PORTABLE AERONAUTICAL SERVICE UNIT: *Mobile frame electric power generating set, searchlight and floodlights.*—R. A. Lister & Co., Ltd.
30935. TREATMENT OF THE SURFACE OF GLASS TO REDUCE THE PROPORTION OF INCIDENT LIGHT REFLECTED HEREBY: *Repeatedly wetting with a solution of silicon tetrachloride and drying.*—Pilkington Brothers Ltd.
30944. OIL CLOTH. *Applying to fabric a composition prepared from a mixture of nitrated cellulose and a nitrated suphonated or vulcanised oil.*—Government Industrial Laboratory. H.E.H. the Nizam's Government.
30952. AN ELECTRIC CONTROLLING DEVICE: *Use of a tendjed gap to control operation of electric control device.*—M. N. Yardeny.
30958. ANTENNAE ASSEMBLIES. *Flexible rod: antenna secured by spiring means at one end and releasably held but free end.*—Zenith Radio Corporation.
30970. ELECTRICAL EXCESS VOLTAGE PROTECTIVE DEVICES: *Envelope containing inert gas and two spaced convex shaped electrodes of iron, steel or nickel which have different metal parts at the nearest point of approach.*—Siemens Electric Lamps and Supplies Ltd.
30990. TELEPHONE INSTRUMENTS: *Handset enclosed when not in use in dust tight casing.*—Automatic Telephone and Electric Co., Ltd.
31032. SAFETY RAZOR BLADES AND SAFETY RAZORS: *Blade having corner recesses and a central longitudinal slot intersecting one transverse edge which lies within the confines of razor head.*—Gillette Safety Razor Company.
31132. MAGAZINE SAFETY RAZORS: *A member providing a blade seat and guard, and a blade clamp having a portion which slides parallel to blade seat.*—Gillette Safety Razor Co.
31221. LOCKS: *Locks of the type in which the casing is of laminated construction.*—Master Lock Co.
31236. TOXIC COMPOSITION PARTICULARLY SUITABLE FOR FUMIGATING AND DISINFECTING SOILS: *Mixture of unsaturated and saturated hydrogenated hydrocarbons.*—Shell Development Co.
31254. BURNING MASTARD OIL IN HURRICANE LANTERN: *Two L-tubes connected to oil reservoir at the top for regulating flow of oil.*—K. C. Nijhawan.
31328. LOOSE LEAF BINDERS: *By the kind in which pair of covers are connected by thongs.*—Kalamazoo Ltd.
31749. FISHING RODS: *Detachable pieces, bottom ones hollow and top ones of smaller diameter can be placed inside the hollow pieces to carry all as a stick.*—Pal & Co.
31766. JETS FOR BLOW-LAMPS: *Main jet embersed in a cupped orifice and cut and ran below to admit pilot jet striking it vertically.*—H. H. Grey.
31826. SERVO BRAKE OPERATING MECHANISM FOR VEHICLES: *Two independent control levers, and main and auxiliary servo devices.*—Clayton Dewandre Co. Ltd.
31827. REACTION VALVE DEVICES FOR BRAKE OPERATION: *Pressure applied to pedal is transmitted through levers to valve for application of vacuum or pressure fluid.*—Clayton Dewandre Company Limited and another.
31843. SUPPORTS FOR RAILWAY SIGNAL LAMPS: *The adjustable seating plate supporting lamp by means of one fixed and other moveable plug.*—R. G. Esteves.
31887. MAKING DEFORMATIONS, GROOVES, OR FLUTES IN TUBES: *A chuck with multiplicity of cavities extending radially with pressrollers therein*

- co-operating with die with a winch for drawing.*—The Industry Managers (India) Limited.
31909. MOVING COIL LOUDSPEAKERS OR MICROPHONES with one or more layers of iron dust incorporated between the former and adjacent layer of wire and/or successive layers of wire.—The Mullard Radio Valve Co., Ltd.
31993. BONDED REFRACTORIES FOR FURNACE LININGS: *Mixing magnesia containing particles with sulphuric acid and a sulphate and moulding.*—Canadian Refractories Ltd.
32016. LEVULOSE—CONTAINING SIRUP: *Subjecting the inverted liquor to treatment with resin.*—Corn Products Refining Co.
32414. WATERPROOF FIBROUS COMPOSITIONS: *Impregnating the sheet or fabric with a waterproof material which is plastic cement or adhesive.*—C. M. Baskin.
30498. FILTERING MEANS, FOR THE AIR-INTAKE OF AIRCRAFT ENGINES: *A pleated filter with zig-zag sealing member closing the ends of the folds.*—Vokes, Limited.
30499. AIR CLEANERS: *An air passage of annular cross-section curved round radially and axially in combination with a dust-trap.*—Vokes, Limited.
30500. FILTERS: *An assembly of deeply pleated filtering screens with tapered walls to form a composite screen of zig-zag cross-section.*—Vokes, Limited.
30501. EXHAUST SILENCERS: *Thickness of the wall over greater part of the circumference of cylinder through which gaseous currents flow includes two thickness.*—Vokes, Limited.
30536. COMBINED AIR FILTERS AND SILENCERS: *Casing with flat walls, outlet, sound absorbing lining, passage and plugs of filtering material.*—Vokes, Limited.
30565. PRESERVATION OF LEATHER: *Applying to the leather a liquid solution which contains both oil of turpentine and citronella oil.*—Victor Penha.
30605. ACTIVE PRINCIPLES FROM LIVER: *Digesting liver with an enzyme and destroying it by heat.*—Evans Sons Lescher & Webb, Limited.
30920. FREQUENCY CHANGERS: *Supplied with A. C. current of one frequency to generate currents of two mutually self-exciting frequencies differently from supply frequency.*—Automatic Electric Laboratories Inc.
30946. ROTARY VALVE ASSEMBLIES FOR INTERNAL COMBUSTION ENGINES, COMPRESSORS AND THE LIKE: *Rotary valve member having tapered bearing surface with its housing and a passage which opens in the cylinder which has an opening smaller than adjacent end of valve member.*—F. M. Aspin.
30955. LUBRICANTS: *Mineral lubricating oil having dissolved therein an alicarbo-cyclic alcohol or its estere.*—Shell Development Company.
31228. TREATING A METAL COATING APPLIED TO A METAL STRIP: *Moving continuously coated strip through a body of hot liquid floating on a cooling liquid.*—Davy and another.
31422. FERMENTATION: *Consists in the reuse of microorganisms derived from fermented beer.*—A. V. V. Iyengar.
31433. BURNER CONSTRUCTIONS FOR GASOLINE MANTLE LAMPS: *Bore of mixing tube such that the velocity of fuel mixture is greater than rate of flame propagation.*—The Mantle Lamp Company of America.
31513. FLUX MEASUREMENTS: *Direct current measuring system into a metering circuit and flux measuring circuit.*—I. G. E. C. Inc.
31718. BUG-PROOF CAMP COT: *Canvas detachably attached to wooden frames at long sides by string.*—J. E. Moses.
31916. PORTABLE CHISELS: *Chisel mounted in a tubular body and operated by a reciprocable plunger includes detachable chuck and spring at operating end of the said body.*—H. Barker Bland.
31931. AUTOMATIC COUNTER SCALES: *Scale plate, lever, pendulous or other automatic weight resistant and rotatable graduated cylinder.*—W. & T. Avery, Limited.
32049. STAINLESS STEEL: *Melting a charge of one or more chrom-bearing materials with a fluxing agent rich in Titaniumoxide and adding a non-Carbonaceous reducing agent.*—Alloy Research Corporation.
30508. CUSHIONING STRUCTURES FOR SEATS: *Readily deformable resilient cushion body and readily deformable resilient plastic fabric covering.*—The Firestone Tyre & Rubber Company.
30645. CALCINING OR ROASTING MATERIALS: *Discharging variably the material to be processed through a processing zone.*—T. R. Ellerbeck.
30860. PROTECTING THE LENSES AND OTHER OPTICAL PARTS OF OPTICAL INSTRUMENTS FROM DETERIORATION BY FUNGUS, MILDEW OR THE LIKE: *Containing a fungicide in a non-drying vehicle.*—Lens & Scientific Instrument Co., Ltd.
30932. INSPECTING, CLASSIFYING AND COUNTING ELECTROLYTICALLY COATED SHEETS: *Inspecting and automatically separating defectives and coating the properly coated sheets.*—Carnegie-Illinois Steel Corporation.
30942. TREATING WOVEN TEXTILE FABRICS TO STRAIGHTEN THE WEFTS THEREOF: *Two pairs of rollers engaging the selvedge, to rotate at a different peripheral speeds controlled by the lateral deflection of the web.*—Tootal Broadhurst Lee Company, Limited.
30950. WATER HEATERS: *A transversely placed baffle or deflector at the end of the flue adjacent to the combustion chamber to deflect gases passing the upper part of the flue.*—G. S. Milner.
30951. WATER HEATERS AND CIRCULATION OF DRAUGHT AND WATER THEREIN: *Opening spaced around the periphery of the inner portion of the hollow door to discharge air around the inner surface of the flue.*—G. S. Milner.
30954. FOAM GENERATING AGENTS: *Hydrolysing proteinaceous material in presence of water with the aid of oxides or hydroxide having medium basic properties.*—Wormald Brothers Pty., Limited.
30956. INDICATING APPARATUS, SUCH AS FOR STATISTICAL CONTROL CHARTS: *A bank of holes for selectively receiving indicating pegs secured with cords having tension springs at the rear of the board.*—F. L. Wassel.
31025. A ROTARY SHUTTLE FOR SEWING MACHINES: *For movable part, the bearing surface of steel, for stationary part, that of non-metallic body and combination of three annular pieces.*—Mefina S. A.
31091. FREQUENCY DISCRIMINATING ELECTRIC CIRCUITS: *Valve amplifier, output terminals of which comprise capacitor and inductor in series, a pair of diodes and resistor.*—G. E. C. Ltd.
31100. ELECTRIC DISCHARGE DEVICES HAVING BLACKENED ELECTRODES: *Electrode that is heated during operation is coated with titanium dioxide.*—The M-O Valve Company, Limited.



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REGIONAL DISTRIBUTION OF INDUSTRIES

IN a recent memorandum* issued by the Office of the Economic Adviser to the Government of India, attention is directed to the location of industry as an important aspect of industrial planning. A correct appreciation of the principles of industrial location is necessary not only to check the agglomeration of industries in particular localities with all its concomitant social evils, but also to minimize the disparities in living standards which obtain in different parts of the country. Aggregation of industries in vulnerable areas has to be prevented also for strategic reasons. Industrial development in India has been haphazard, and the absence of any plan or policy has resulted in the concentration of industries in certain localities, notably in Bombay, 24-Parganas, Howrah, Ahmedabad and Cawnpore. That the distribution of industries is uneven, not merely absolutely but also in relation to the distribution of population, is manifest from the data furnished in the memorandum. No less than 52 per cent. of the total number of factory workers is found in the two Provinces, Bengal and Bombay†. These two Provinces with a population of 15 and 5 per cent. respectively, of the total population of India, employ 29 and 23 per cent. of industrial workers in their factories, while the United Provinces, Madras and Bihar with 14, 13 and 9 per cent. of the population,

employ 8, 10 and 5 per cent. of the industrial workers. The figures for other Provinces show greater disparities. The economy of India is already unbalanced owing to excessive dependence of the population on agriculture, and the uneven distribution of industries has greatly aggravated the situation.

The memorandum discusses the principles which govern industrial location and the dynamics of the various forces which pull an industry to different geographical points. The dominant consideration in the choice of a site for industrial location is efficiency of production and distribution. In some cases the location is determined by the availability of specific natural advantages, as in the case of the iron and steel industries located in close proximity to the coalfields and the iron mines of Bihar and Bengal. Industries with an export market, e.g., cotton and jute, tend to concentrate in ports and commercial centres. Industries processing perishable materials like fish, fruits and vegetables, are located close to the source. The choice of a site is not, however, conditioned by such simple considerations. The primary location factors for an industry are transport, labour and finance. Raw materials have to be transported to the site of the factory and finished goods conveyed to the consuming markets. The attractive power of the source of raw materials is assessed by the ratio of the weight of the materials processed to the weight of the finished product, or the *material index* as it is called. All industries

* *The location of industry in India*, (Office of the Economic Adviser to the Government of India, New Delhi), 1945.

† Census, 1931.

whose material index is less than 1 lie at the place of consumption. Industries producing finished articles containing much value in small bulk, and are capable of being conveyed over long distances at a relatively low cost, tend to be located at the site of the material. Some industries permit of split locations, that is, the materials are capable of being processed in independent stages and in different centres. Thus in the paper industry, the production of pulp and the manufacture of paper are two independent stages, and as the production of pulp involves a considerable loss in the weight of the raw material, the pulp industry can be located with advantage at the source, and the manufacture of paper at the consuming centre.

The importance of labour as a locational factor is determined by the ratio of the labour cost to the total cost of production. The higher the ratio, the greater is the importance of labour as a locational factor in industry. Industries like leather, lumber, textiles, automobiles and wearing apparel in which labour amounts to 47 per cent. of the total cost of production, are naturally attracted to the regions where labour is plentiful and cheap. In tobacco manufactures, chemicals and allied products and food products, labour represents less than 25 per cent. of the cost and for this reason labour does not determine the location of such industries.

The availability of finance for industrial enterprise is greatly influenced by the investment habits of the local population, level of taxation and the prevalence of banking facilities. The degree of assistance offered to *entrepreneurs* by local authorities vary greatly in different regions. The growth of industries in Indian States during the last decade is in no small measure due to the various inducements offered by the State Governments. It is, however, important that facilities offered by different regions should conform to a national plan. Otherwise, they tend to disrupt the territorial distribution of labour and introduce unhealthy rivalry among different areas.

There are a large number of factors, other than those mentioned above, which determine the choice of a site for industrial location. The most important among them is the availability of fuel. The concentration of industrial activity around the coalfields of Bihar and Bengal is primarily due to the availability of coal. The disadvantage from

which regions removed from coalfields suffer, has been partly or wholly overcome by the development of alternative sources of power, notably hydro-electric power. The emergence of electricity as a competitor to steam power has greatly diminished the attractive power of coalfields. The industries in the Bombay area are mainly based on hydro-electric power. Established industries often exercise considerable attraction to other industries and constitute an important factor of agglomeration. Industries of an allied character, those that utilize the by-products of established industries and those that supply equipment and components are attracted to industrial areas. Such regions serve as reservoirs of labour and of technical, professional, banking, insurance, marketing and other services, and are particularly attractive to light industries for which availability of external economics is of particular importance.

From what has been briefly stated above, the location of industry is governed by a great many complex factors. Free functioning of private enterprise does not necessarily contribute to the selection of the optimum location for a given industry. While there are industries for which specified localities offer special advantages, there are others which can thrive under widely different types of environment. The provision of transport facilities—waterways, roads and railways—and the development of power resources, tend to minimize the importance of privileged areas. A detailed survey of the natural resources—mineral, agricultural, forest and marine—are likely to reveal the potentialities of new regions for industrial location. These developments will establish a new set of conditions which will affect the pattern of industrial location. India is still an undeveloped country. Her raw materials are widely scattered and many resources have not yet been charted. There is no dearth for labour in any region. These are factors in the Indian situation which offer great hopes for the future. What is required is a policy and the conscious direction of industrial activity on the basis of a comprehensive national plan.

The regional development of industries, which aims at a reasonable balance between industry and population throughout the country, to be effective, should have the co-operation of local, regional, provincial and national agencies. Industrial development in advanced countries is planned and

directed by national organizations and are actively supported by the State. The activities of the National Resources Board and the various State Planning Boards in the U.S.A. are so directed that they ensure a balanced distribution of industries. Planned development has led to the urbanisation of the bulk of the population. In India, hardly 16 per cent. of the population lives in towns (population 5,000 and above). The dispersal of industries help the growth of a large number of towns and facilitate the provision of educational, medical, public health and other social amenities. From whatever angle the problem is viewed—social, economic, and strategic—the distribution of industries

is necessary and should form an essential feature of any reconstruction programme. State aid, and even intervention, is called for, for developing backward areas and for preventing the overgrowth of industrial centres. In their Statement of Industrial Policy, the Government of India have laid great stress on the regionalization of industries. Progressive opinion is in favour of such a policy. It is to be hoped that early steps will be taken to establish the necessary machinery to determine the industrial potentialities of different regions and to assist industrialists in the choice of sites for the location of new plants and in the problem of industrial development, generally.

THE ATOM BOMB

THE news that the first atom bomb was dropped on Hiroshima in Japan on the 6th of this month, with devastating results literally “searing to death all living things, human and animal,” has staggered the world. The new weapon which the Allies have employed for beating the enemy into surrender, surpasses all others in its destruction, and represents the triumph of science in harnessing the gigantic energy locked up in the tiny but mighty atom. The details relating to the mechanism of the new weapon are not available as yet. The source of energy for the atom bomb is the fission of the uranium²³⁵ isotope, which forms but a minute fraction of the total uranium which occurs in pitchblende. The isolation of the isotope in quantities sufficiently large for practical application, offered insuperable difficulties, and an entirely new technique had to be developed for rendering the isolation possible. The bombardment of uranium²³⁵ by neutrons leads to the splitting of the uranium atom and the release of a terrific quantity of energy. The fission of the atom sets free secondary neutrons, which in turn split up more atoms of uranium thus leading to a chain of atom fissions and the release of enormous quantities of energy in a very short interval of time. While the scientists had long been aware that the energy stored up in the atom was of a colossal and cosmic order, the possibility of controlling its release had eluded them so far. The first result of the success in this direction is the atom bomb.

The destruction caused by the atom bomb has been described in considerable detail in the news-

papers. So staggering is the annihilation caused by it, that serious attention is being directed to ways and means of controlling its use. The new weapon is a naked terror which has in it the potentialities of either destroying the entire civilization which created it, or banishing all wars for ever. War can destroy itself through its own perfection! The fact that atomic energy can be released and utilized, ushers in an era of development, in which the new energy can be utilized to supplement the power from coal, oil and waterfalls. What has been achieved at the expense of \$2,000,000,000, and through the intimate collaboration of the top-ranking scientists of many countries should be utilized, now that its lethal purpose has been fulfilled, for constructive ends to ensure human happiness. While it was distressing to find that the gifts of science were being hitherto perverted to cause death and destruction, it is possible to foresee a time when the same gifts will be utilized for sublime and humane ends. The scientists who have created the knowledge with such immense possibilities for good or for ill, have the grave responsibility of exerting themselves in favour of the good and against the ill. While some form of international control over the uranium resources of the world is inevitable as a safeguard against the abuse of the new weapon, it is even more essential that the scientist should take the firm resolution, in the interests of humanity, that he will never use his talents to devise weapons of death and destruction, but use them *solely* for the advancement of human happiness and welfare.

STUDIES IN THE CONSTITUENTS OF CHANA (*CICER ARIETINUM*, LINN)

PART I—ISOLATION OF THREE NEW CRYSTALLINE PRODUCTS FROM THE CHANA GERM

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CHANA (Bengal gram) occupies a very important position among the staple foodstuffs of India, particularly with the poorer classes, on account of its comparatively low price and high nutritive value. It is eaten raw, roasted or cooked, and a large variety of saltish and sweet preparations are made from it. In the indigenous system of dietetics and medicine, exceptionally nutritive and body building properties are ascribed to it. In particular, *chana* soaked overnight in water and the sprouted grain, are both considered to be extremely nourishing and constitute a regular item of diet for athletes and professional wrestlers in India. In Europe, roasted *chana* appears to be a popular foodstuff in Bulgaria under the vernacular name *Leblebiji*.

In view of the importance of *chana* in the Indian diet as briefly indicated above and the apparent lack of any systematic work on the germinated grain, a study of the chemical constituents of the *chana* germ was considered of interest as a part of a general scheme of comprehensive studies on this problem.

As a result of the present work, the following three new crystalline products have been isolated and characterized:—

1. *Bio-chanin A*, $C_{16}H_{12}O_5$: pale yellow, short, curved, tapering rods, m.p. $212^\circ C.$, yield 0.005 per cent. on the weight of the dry grain.
2. *Bio-chanin B*, $C_{15}H_{12}O_4$: colourless, prismatic rods, m.p. $250^\circ C.$, yield 0.004 per cent. on the weight of the dry grain.
3. *Bio-chanin C*, $C_6H_{13}O_4N_3$: colourless, large prisms, m.p. $310^\circ C.$ (d).

The best method for the extraction of these products was through the alcoholic dialysis of the fresh whole germ, handpicked from the sprouting grain on attaining an average length of 1.5" corresponding to an average weight of 7.5 per cent. on the weight of the dry grain.

In the course of investigations which finally led to this method, it was observed that both *bio-chanin A* and *B* deteriorate if the germ is dried at ordinary temperature in the shade and that their concentration which is about the highest at the start, steadily decreases with the growth of the germ. These observations are of special significance to the study of the products, as they indicate the possibility of their exerting a specific biotic function in the initial stages of germination. It is also out of this consideration that the names noted above have been provisionally assigned to them.

The isolation of the individual products was based on a systematic fractionation of the concentrate, obtained on removal of the solvent from the combined dialysates *in vacuo*, through various organic solvents without the use of any chemical reagents. Following this procedure a mixture of *bio-chanin A* and *bio-chanin B* was obtained from the petroleum ether-insoluble, ether-soluble fraction and their separation was effected through repeated fractional crystallization from ether, acetone and alcohol, in which *bio-chanin A* is comparatively more soluble. Some of the middle fractions obtained in the process of separation showed intermediate melting points and behaved in this respect like uniform products. They are, however, to be regarded as eutectic mixtures of *bio-chanin A* and *B*, and by a tedious process of further fractionation it was possible to effect a partial separation of the two components. *Bio-chanin C* was obtained from the ether-insoluble fraction of the alcoholic concentrate through fractional separation with dilute alcohol and repeated crystallization of the crude crystallisate from alcohol and water.

The experimental in this communication records only the final procedure evolved for obtaining the products noted above from the fresh germ. Further details of the experimental data as well as the results

of a general chemical examination of the germ will form part of a subsequent communication on the subject. Studies in the chemical constitution of the products are in progress, and a thorough investigation of their function as possible growth-promoting factors in the plant and their action on the animal system is projected.

Experimental

10 kgs. of *chana* were soaked in water for 24 hours and then allowed to germinate at room temperature in hanging baskets to ensure sufficient aeration, until the germs attained an average length of 1½". It took 48 to 60 hours to reach this stage and the grain was kept moist during this period by occasional sprinkling with water. The germs were separated by hand picking (yield, 1 kg. in the fresh condition) and dialysed with rectified spirit at room temperature. After 24 hours the first dialysate was collected and fresh solvent added on. After four such operations which were sufficient to extract most of the crystalline material, the solvent was removed from the combined dialysates in *vacuo* and the slightly emulsive concentrate containing the crystalline matter was filtered.

The crystalline product obtained on filtration was dried on porous plates and repeatedly extracted with petrol ether. The petroleum ether-insoluble residue was then crystallized from acetone and alcohol, when a mixture of bio-chanin A and B was obtained as a cream coloured crystalline powder in a total yield of 2 gms. which works out to 0.02 per cent. on the weight of the original dry grain or 0.2 per cent. on the weight of the fresh germ. Bio-chanin A and bio-chanin B were separated from the mixture by a long and rather complicated process of fractional crystallization from alcohol, ether and acetone, at the end of which 0.5 gm. of bio-chanin A, 0.4 gm. of bio-chanin B and about 0.8 gm. of eutectic mixture of bio-chanin A and B were finally obtained. The isolation of pure bio-chanin B was comparatively easier as it is more sparingly soluble in these solvents than bio-chanin A, which concentrates in the tail fractions. Bio-chanin C was isolated from the ether insoluble portion of the concentrated dialysate, left after removal of crude bio-chanin. On fractionating off the products insoluble in 50 per cent. alcohol, bio-chanin C began to crystallize out slowly from the dilute

alcoholic solution, after keeping for a few days in the cold. The crystals were carefully collected and repeatedly crystallized from dilute alcohol and dilute acetone, till the melting point was constant at 310° C.

Characterization

Bio-chanin A ($C_{16}H_{12}O_5$):—Bio-chanin A forms short pale yellow, curved, tapering rods, melting at 212° C. It is readily soluble in acetone, fairly soluble in alcohol, less so in chloroform, ethyl acetate and ether, insoluble in petrol ether. It dissolves in dilute alkali giving a bright yellow colour and its alcoholic solution gives a dark reddish violet coloration with ferric chloride, indicating its phenolic character. In concentrated sulphuric acid, it dissolves with a slightly yellowish colour. With concentrated nitric acid it gives a reddish brown to light red solutions according to the concentration of the substance. It does not give a precipitate with lead acetate in alcoholic medium, even on neutralization with ammonia. On melting the substance and crystallizing the melt from alcohol, the original substance is recovered. It is unsaturated to bromine and contains one methoxyl group

(Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 , C, 68.28; H, 4.30 (micro); C, 68.27; H, 4.28 (semi-micro); M.W. (after Rast) 267; OCH_3 , 5.4; calculated for $C_{16}H_{12}O_5$, C, 67.61; H, 4.23; M.W., 284; OCH_3 (for one), 5.5)

Bio-chanin B ($C_{15}H_{12}O_4$):—Bio-chanin B forms colourless prismatic rods, melting at 250° C. It is fairly soluble in acetone, less soluble in alcohol, sparingly soluble in chloroform, ethyl acetate and ether and insoluble in petrol ether. It dissolves in alkali giving a bright yellow solution and its alcoholic solution gives a greenish violet colour with ferric chloride, indicating the presence of a phenolic group in its molecule. Its behaviour with concentrated sulphuric acid and with alcoholic lead acetate is similar to that of bio-chanin A. With concentrated nitric acid it gives a light yellow solution. On melting and crystallizing the melt from alcohol, it is recovered unchanged. Like bio-chanin A, it contains one methoxyl group in its molecule—

(Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 ; C, 71.00; H, 4.59 (micro); C, 70.60; H, 4.52 (semi-micro); OCH_3 , 6.3; calculated for $C_{15}H_{12}O_4$,

C, 70.31; H, 4.69; OCH₃, (required for one), 5.9.

Bio-chanin C (C₆H₁₃O₄N₃):—Bio-chanin C crystallizes in large colourless prisms, melting at 310° C. It is soluble in water, less soluble in dilute alcohol and acetone, insoluble in absolute alcohol, ether and petrol ether.

(Found after drying to constant weight at 100° C. in *vacuo* over P₂O₅; C, 37.30; H, 6.83 (micro); C, 37.49; H, 6.98; N,

20.95 (semi-micro); N-CH₃ and OCH₃ both absent; calculated for C₆H₁₃O₄N₃, C, 37.70; H, 6.81; N, 22.0.)

Acknowledgement

The micro estimations recorded in this paper were carried out according to Pregl's method by Mr. N. Ghosh of the University College of Science, Calcutta, and the semi-micro estimations by Mr. R. C. Tewari, to both of whom the author wishes to express his thanks.

CHEMICAL METHODS OF PRESERVATION OF GLANDS

By B. B. DEY, P. S. KRISHNAN, V. SRINIVASAN AND M. GIRIRAJ

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THE results of the investigations on the physical methods for the preservation of glands reported previously^{1, 2, 3} would indicate that the ideal method for the storage and transport of glands would be in the frozen condition. However, facilities for the transport of material in the frozen condition, such as wagons fitted with refrigeratory machinery, are not available at present in most parts of India and it was, therefore, thought that as a second best measure it might be possible to store and preserve the glands by chemical methods, whereby the use of ice and refrigeratory machinery would be dispensed with. The following investigations concern themselves with the chemical treatment of the thyroid, the adrenal and the pituitary glands with a view to the preserving of their active principles.

Preservation of Thyroid Glands

The glands were dissected out fresh from the animals and after removal of the connective tissue, dropped immediately into (a) acetone* (b) alcohol* and (c) toluene: they were transported in this condition from the slaughter-house to the laboratory, where they were stored for a period of one week at the ordinary temperature. At the end of this period the glands were worked up for the preparation of desiccated powder. Analyses of the total and the thyroxine

iodine of the specimens so obtained showed practically no difference from those obtained for the desiccated powders from fresh glands, or glands frozen for the period of one week (*vide* Table I). Additional check was forthcoming from the fact that the desiccated powders so obtained yielded, after the first stage of hydrolysis with 10 per cent. baryta, two fractions A and B which corresponded, within the margin of experimental error, with the two fractions obtained by similar hydrolysis of powder prepared from the fresh glands, both in net weight and in iodine content (*vide* Table II).

These results would go to show that thyroid glands could be preserved in alcohol and acetone for a period of several days.

TABLE I. Comparison of the Physical and the Chemical Methods of Preservation of Thyroid Glands.

Specimen.	Total I. Thyroxine		Total I.
	%	%	
Fresh glands	(a) 0.9839	0.3420	34.75
	(b) 0.9954	0.3623	36.40
	(c) 1.052	0.3638	34.58
Glands frozen for one week at -7°C.	(a) 0.9540	0.3530	37.01
	(b) 0.9512	0.3825	40.22
	(c) 0.9579	0.3659	38.21
Glands stored under acetone for one week.	(a) 0.9772	0.3890	39.80
	(b) 0.9967	0.3910	39.20
	(c) 1.077	0.3950	36.67
Glands stored under alcohol for one week.	(a) 1.025	0.3943	38.47
	(b) 0.9595	0.3397	35.41
	(c) 0.9732	0.3752	38.55
Glands stored* under toluene for one week.	0.9759	0.3423	35.08

*The alcohol employed was 90—93 per cent. Dry acetone was employed. For every 100 gms. of gland material, 300—500 c.c. of desiccating reagent were used.

*The experiment was not repeated since the glands under these conditions were found to develop an objectionable odour indicating putrefaction.

TABLE II. *Hydrolysis of the Different Specimens of Desiccated Thyroid.*

(250 gm. of powder with 10 per cent. baryta for 6 hours.)

Specimen.	A. Fraction (soluble in $\text{Ba}(\text{OH})_2$)		B. Fraction (insoluble in $\text{Ba}(\text{OH})_2$)	
	Yield gm.	I content %	Yield gm.	I content %
Fresh glands ..	(a) 8.23	7.60	13.0	3.0
	(b) 7.13	8.85	10.7	3.44
	(c) 8.0	7.77	11.5	3.60
Glands stored under acetone for one week.	6.93	8.64	10.8	3.12
Glands stored under alcohol for one week.	7.70	9.22	12.97	2.64

Preservation of Adrenal Glands

The method of investigation consisted in storing adrenal glands in contact with alcohol, acetone and toluene for a period of one week at the ordinary temperature and working up the glands at the end of the period for the isolation of adrenaline by methods standardized in this laboratory.

The adrenal glands were dissected out fresh from slaughtered cattle and after the mechanical removal of fat and connective tissue, they were dropped into wide-mouthed bottles containing acidified alcohol. The bottles were tightly stoppered to prevent the access of air and transported to the laboratory, where they were stored for a period of one week at the ordinary temperature of 30°C. In a similar way other batches of glands were collected and stored under acetone and also toluene. At the end of seven days the glands stored under alcohol and acetone were separately minced with the solvent with which they had been in contact and the extracts processed for the isolation of adrenaline. In separate experiments it was shown by quantitative estimations that when adrenal glands were kept in contact with alcohol or acetone for a period of seven days about 50 and 40 per cent. respectively of the hormone was found to have diffused out into the solvent layer; hence the necessity for mincing the glands along with the alcohol or acetone with which they had been preserved. In the case of toluene, however, no adrenaline was found to have diffused out; the glands were therefore mechanically freed from toluene and minced and worked up for adrenaline. In Table III the yields of adrenaline from chemically treated glands are compared against those from the fresh glands, as well as from glands

which had been kept frozen for periods of one to four weeks. It will be evident that the yields of adrenaline from the chemically treated glands compare very favourably with the yields from fresh and frozen glands. It might also be mentioned that between alcohol and acetone, the former is a better medium for the storage of adrenal glands.

In the case of both the thyroid and the adrenal glands, it was found that treatment with alcohol or acetone renders the tissue hard and difficult to mince subsequently. The toluene-treated glands retain their fresh consistency, but cannot be recommended for routine use, since the glands begin to develop an objectionable odour after about five days when left at ordinary temperature: the yield of adrenaline is, however, quite satisfactory. The respective solvents can in all cases be recovered and used over again.

Preservation of Pituitary Glands

Unlike the thyroid and the adrenal glands, the cleaning of the pituitary gland free from connective tissue is a delicate operation which is best carried out in the laboratory under expert supervision. The glands being

TABLE III. *Yields of Adrenaline from Glands Preserved by Physical and Chemical Methods.*

Method of treatment.	Yield of crude adrenaline.	Purity of specimen (colorimetric assay)
		%
Fresh glands	(a) 0.20	75.00
	(b) 0.22	80.00
	(c) 0.21	80.32
	(d) 0.21	78.87
Glands frozen for one week in freezing chamber of <i>frigidaire</i> .	(a) 0.22	71.39
	(b) 0.21	73.36
	(c) 0.21	78.34
Glands frozen for two weeks.	(a) 0.20	76.30
	(b) 0.19	78.08
	(c) 0.19	74.54
Glands frozen for one month.	(a) 0.20	74.00
	(b) 0.20	72.90
	(c) 0.19	76.50
Glands stored under alcohol for one week.	(a) 0.20	77.61
	(b) 0.21	77.02
	(c) 0.20	80.04
Glands stored under acetone for one week.	(a) 0.16	75.00
	(b) 0.18	75.06
	(c) 0.18	73.72
	(d) 0.18	74.82
Glands stored under toluene for one week.	(a) 0.21	79.69
	(b) 0.20	78.07
	(c) 0.22	80.00

tiny are difficult to handle and the posterior lobe especially which is very soft in texture gets torn off, unless the connective tissue is removed gently and dexterously with special scalpels and scissors.

The aim of the present investigation was to prepare posterior pituitary powder from

the different batches of chemically treated glands and to compare their biological potencies. The pituitary glands after gross trimming from dura mater, bone splinters, etc., but still retaining the connective tissue sheath in tact, were dropped into acetone and transported to the laboratory, where they were stored in this condition for periods varying from 3 to 7 days. At the end of the period the glands were taken out of the acetone, the connective tissue removed, the glands dissected carefully and the posterior lobes worked up for the preparation of dried powder by standard methods. In the following table (Table IV) the potencies (as determined by bioassay method at the *Biochemical Standardization Laboratory, Calcutta*) of the specimens obtained from the chemically treated glands are compared against those obtained from glands which were either fresh or had been kept frozen for varying periods of time. It will be apparent from the table that the potency of the powders prepared from glands stored in acetone upto a period of one week compares favourably with that of powders prepared from fresh glands or glands stored frozen. It would, therefore, be quite feasible to transport pituitary glands stored in acetone or in alcohol, which is also a good dehydrating agent.

It has, however, to be pointed out that during storage of the pituitary glands under acetone or alcohol the glands get hardened: the connective tissue becomes difficult to remove and what is more important, the demarkation between the posterior and the anterior lobes gets blurred, especially in the case of the glands from cows and oxen,

TABLE IV. *Potencies of Posterior Pituitary Powders Processed from Glands Stored under Different Conditions.*

Method of treatment.	Potency of powder.	
	I.	U. per mg.
Fresh glands	(a)	10.0
	(b)	10.0
	(c)	10.0
Glands frozen for 3 days	(a)	9.09
	(b)	8.88
	(c)	10.0
Glands frozen for 7 days	(a)	10.0
	(b)	8.69
	(c)	9.09
Glands stored under acetone for 3 days.	(a)	10.0
	(b)	10.0
	(c)	8.33
Glands stored under acetone for 7 days.	(a)	10.0
	(b)	10.0
	(c)	8.33

whose posterior lobes are smaller than those of the buffaloes⁴. This difficulty

could be overcome to an extent by soaking the glands for a few minutes in ice-cold water, when the glands absorb water and tend to assume the consistency of the fresh glands.

It might also be mentioned that if the dissection of the glands could be carried out in the vicinity of the slaughter itself, the dissected posterior lobes could be dropped into acetone or alcohol and transported in contact with the dehydrating agents: under these conditions the posterior lobe material has been found to retain its oxytocic potency unimpaired for several days.

Conclusion

From the experiments briefly reported above, it will be apparent that chemical methods of storage of the glands meet the immediate requirements of the preparation of certain particular active principles, e.g., adrenaline from the adrenal glands and posterior pituitary powder from pituitary glands. It has, however, to be borne in mind that chemically treated glands may not be equally suited for the preparation of certain other hormones, say, the cortical and some of the anterior pituitary hormones. Moreover, the tissues get hardened by contact with alcohol or acetone and the subsequent mincing and extraction are more difficult to carry out. Immediate freezing of the glands and storage in frozen condition would thus be the ideal method: for, in this case the glands retain their fresh consistency even after the lapse of several weeks; the concentrations of the active principles also do not undergo any material alteration and the glands could be processed for the isolation of any or all the active principles.

The expenses of these investigations were met entirely from funds provided by the *Council of Scientific and Industrial Research*, to which our grateful thanks are due. We are also greatly indebted to Dr. B. Mukerji, D.Sc., M.D., Director, *Biochemical Standardization Laboratory, Calcutta*, for his helpful co-operation in carrying out the bioassays.

References

- 1 Dey, Krishnan, and Srinivasan, *Curr. Sci.*, 1943, 12, 244.
- 2 Dey, Krishnan and Giriraj, *Curr. Sci.*, 1943, 12, 319.
- 3 *Ibid.*, 1944, 13, 9.
- 4 Dey, Krishnan, Srinivasan and Giriraj, *J.Sci. Ind. Res.*, 1944, 3, 112.
- 5 Dey, Krishnan and Giriraj, *J.Sci. Ind. Res.*, 1944, 3, 160.

THE USE OF DDT AND 666 AS INSECTICIDES AGAINST GRAIN PESTS *

PART I—INCORPORATION OF DDT AND 666 IN WALL WASHES

(From the Ordnance Laboratories, Cawnpore)

Introduction

THE insecticidal efficiency of DDT and 666 against grain pests when the insecticide is mixed with the grain or grain products, or when used as a spray has already been investigated¹. If they could be incorporated, without loss in efficiency, in wall washes which are normally applied to storage sheds, it was thought that this might prove a practical method of checking infestation. There is an advantage in using the insecticide in a whitewash as compared with the use of a direct spray on the wall surface, in that it is always possible to see where the treatment has been applied.

When applied in a wash, the efficiency of an insecticide may be affected by both physical and chemical factors. The physical structure of the insecticide deposit is of evident importance, but the effect will be further modified by the occlusion of some part of the total insecticide content in the lower layers of the wash. The insecticidal effect may be affected from chemical causes through interaction of the lime or other constituent of the wash with the insecticide.

The experiments described in this paper are of a preliminary nature and were designed first to standardize a technique by which the insecticidal efficiency of wall washes could be compared, and second to compare the initial efficiency of DDT and 666 when incorporated in lime and chalk washes in different proportions. Later papers in this series will discuss the nature of the reaction which causes the loss in insecticidal efficiency of DDT and 666 in the presence of lime, and the residual effects of these insecticides when incorporated in varying concentrations and in different types of wall washes.

Experimental

The Insecticides.—The DDT used was a crude product having a pp' isomer content of 85 per cent.

The 666 used contained 10-12 per cent. of the γ isomer of benzene hexachloride.

The concentration figures given in this paper in all cases refer to the crude insecticides.

The Boxes.—The experimental chambers were made from cement concrete, and had internal dimensions of $5\frac{1}{2}$ " x $5\frac{1}{2}$ " x 4", with walls about $1\frac{1}{4}$ " in thickness. The tops were open, and glass plates were cut to serve as covers, being held in place by putty.

The Test Insects.—*Tribolium castaneum*, *Calandra sp.*, and *Rhizopertha dominica* were used. The insects were obtained from a large natural population infesting a local grain store.

Treatments.—*Series I, DDT in Lime-wash.*—Lime-wash was prepared by mixing 300 gm. of slaked lime with 1,200 cc. of water. For the treatment of each box, 200 cc. of this stock wash was mixed with the appropriate quantity of DDT. The mixture was prepared by grinding the DDT in a mortar with gradually increasing quantities of the wash until the whole 200 cc. had been used. Each box was treated with several coats of the DDT wash, until the whole 200 cc. had been applied. Washing was carried out as evenly as possible with a brush, the mixture being constantly agitated to prevent settling out.

Series II, DDT and 666 in Lime and Chalk Washes.—The internal surface area of each box was determined. The amount of chalk or lime to be applied was such that each box would contain the same amount of Ca^{++} per unit area. Approximately 10-11 gm. of chalk per box was required to give a thin uniform coating which would not break on drying, and the quantities of chalk and lime to be applied were calculated on this basis.

Freshly prepared quicklime and precipitated chalk were used. The quantity of chalk or lime required for each box was weighed separately, mixed with twice the weight of water, effecting slaking in the case of the lime, and the requisite quantities of DDT or 666 emulsion added. The resultant thin paste was applied uniformly with a brush to the inner surfaces of the experimental boxes, several coats being applied, until the whole wash had been used up.

* The experiments reported in this series were undertaken at the request of the Director of Storage, Food Department, Government of India, with the permission of the Master General of Ordnance.

Preparation of the master emulsions of *DDT* and *666* was effected as follows:—

Solution A.—

Soft Soap	..	2 gm.
Rosin	..	2 gm.

Solution B.—

Groundnut Oil	16 gm.
Insecticide	.. 10 gm. <i>DDT</i> , or 4 gm. <i>666</i> .
Toluene	.. 24 gm.
Distilled Water	.. 0.2 cc.

Solutions A and B were mixed together and added as required to the wash.

After treatment, the boxes were allowed to dry for 24 hours before use in the biological tests.

The weight of *DDT*, *666*, lime and chalk applied to each box is shown in Table I.

Biological Tests.—The procedure was similar in each series of experiments. 5 gm. of food material (crushed wheat) was placed in each box. The test insects were then admitted, and prevented from escaping by glass plates sealed on to the tops of the boxes with putty. Mortality of the insects was determined at intervals, usually daily, by tipping the whole contents of the box on to a sheet of paper, and examining each insect.

TABLE I. *Treatments with Insecticidal Wall Washes.*

SERIES I.

Treatment No.	Concentration of <i>DDT</i>		Lime*
	Mgm./sq. ft.	As % of lime*	
1	570	1.0	400
2	284	0.5	400
3	142	0.25	400
4	71	0.125	400
5 (control)	..	..	..
6 (control)	..	..	..

SERIES II.

Treatment No.	Treatments	Concentration of insecticide		Concentration of lime* or chalk	
		Mgm./sq. ft.	As % of lime* or chalk	Mgm./sq. in.	
1	CHALK	DDT	69.7	0.55	88.0
2			35.4	0.28	
3			17.6	0.14	
4	CHALK	666	70.4	0.56	88.0
5			34.9	0.28	
6			18.0	0.14	
7	LIME *	DDT	70.6	0.76	64.7
8			35.5	0.38	
9			17.7	0.19	
10	LIME *	666	70.3	0.76	64.7
11			35.3	0.38	
12			17.5	0.19	
13	No treatment
14	Chalk alone	88.0
15	Lime alone	64.7

* In all cases the weights given for lime refer to Calcium hydroxide.

Results

The results are shown in Tables II and III. The results with *Tribolium* and *Calandra* are illustrated in Figs. 1 and 2.

Discussion

The amount of an insecticide applied to a surface in wash may be expressed either in weight per unit surface area or as weight per unit weight of dry matter in the wash. It is evident that neither of these expressions can alone give an adequate measure of the insecticidal activity of the treated surface, since this activity depends upon the quantity of insecticide exposed in the surface layer of the wash when dry. Hence, in all cases in this paper, concentrations of insecticide are expressed in both ways.

Reference to Table I shows that in the first series of experiments the concentration of *DDT* expressed as weight per unit area was much greater than in the second series. The quantity of wash applied was, however, also much greater than in the second series so that the insecticide concentration as a fraction of the wash base was of the same order in both series of experiments.

Although direct comparison of the figures given in Tables II and III is not possible, it can be seen from the trends that the rate of kill produced by *DDT* mixed with lime in series II was more rapid than in series I. This is an unexpected result, as it has been shown (See part II) that *DDT* when mixed with lime in the form of an emulsion as in series II, is rapidly destroyed by the lime, but when dispersed as a solid as in series I there is little or no destruction. It is suggested that the results obtained are due to:

- (1) The fact that *DDT* which separates out from an oil, in an oil-in-water emulsion, will tend to concentrate on the surface of the dried film, while in a solid suspension it will be evenly distributed throughout the film.
- (2) The difference in the physical state of the *DDT* deposited from an emulsion and from a solid suspension.

The results indicate that *DDT* and *666* when mixed with chalk are equally effective against *Calandra* *sp.* and *Rhizopertha dominica* but that *DDT* is slightly more effective against *Tribolium castaneum*.

It is known that benzenehexachloride (*666*) is easily decomposed by bases to form

TABLE II. Mortality of Test Insects at intervals up to 54 Days.

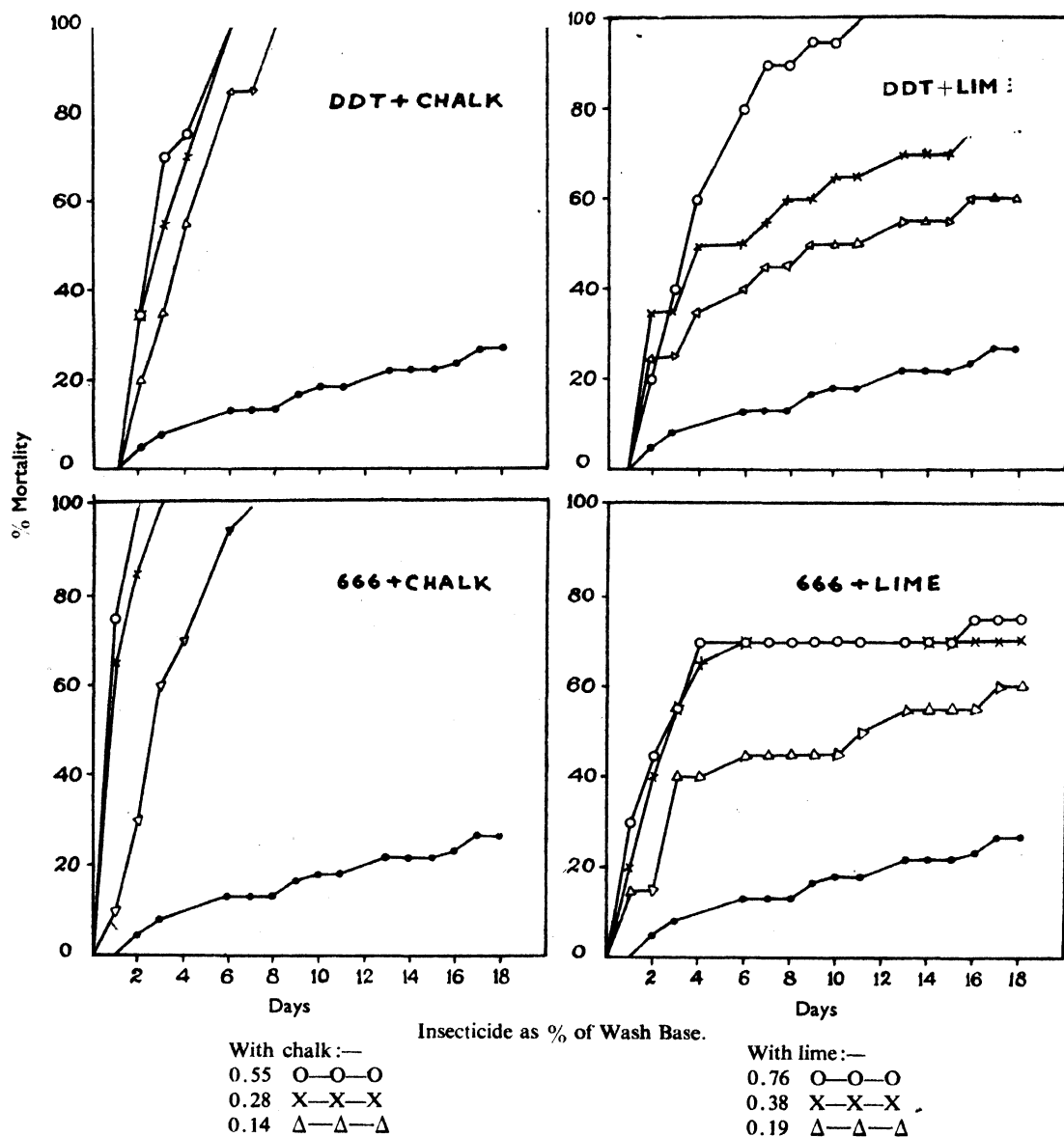
SERIES I.

Treatment No.	7	14	21	Times of exposure in days.						Total No. of insects used.
				28	33	37	44	49	54	
<i>Tribolium castaneum.</i>										
1	12	28	42	50						50
2	4	23	32	39	44	46	50			
3	2	4	5	7	8	9	11	12	15	
4	2	2	3	3	3	3	4	6	12	
5	3	3	3	3	4	4	6	6	10	
6	0	1	2	2	2	4	5	7	9	
<i>Calandra sp.</i>										
1	9	16	19	20						20
2	6	11	18	19	20					
3	1	5	9	15	18	19	20			
4	1	3	7	10	13	13	13	16	16	
5	2	3	5	5	6	6	6	6	6	
6	0	0	0	1	3	4	5	8	9	
<i>Rhizopertha dominica.</i>										
1	5	8	9	10						10
2	7	8	9	10						
3	2	3	4	6	7	8	9	10		
4	1	2	2	4	6	8	8	9	9	
5	0	1	2	4	6	9	9	9	9	
6	0	1	2	3	5	6	6	7	8	

TABLE III. Mortality of Test Insects at intervals upto 18 days.

SERIES II.

Treatment No.	Treatments	1	2	4	6	Times of exposure in days			12	15	17	18	Total No. of insects	
						8	10	11						
<i>Tribolium castaneum.</i>														
1	CHALK	DDT	0	24	36	39							40	
2			0	16	32	38								
3			0	9	28	37	40							
4			8	20	34	39	40							
5			6	15	33	38	40							
6			0	0	4	4	4	10	11	11	13	21		22
7	LIME	DDT	0	9	26	39	40						20	
8			0	3	10	10	11	13	13	16	17	18		18
9			0	2	6	6	7	7	7	11	12	13		13
10			1	3	8	8	9	9	9	10	11	11		12
11			1	1	3	4	6	6	6	7	8	10		12
12			0	1	3	3	4	4	4	5	5	6		8
13	No treatment		0	0	..	1	1	2	2	2	4	4	4	
14	Chalk alone		0	0	..	1	1	2	2	3	3	4	4	
15	Lime alone		0	0	..	1	1	2	2	2	2	4	5	
<i>Calandra sp.</i>														
1	CHALK	DDT	0	7	15	20							20	
2			0	7	14	20								
3			0	4	11	17	20							
4			15	20										
5			13	17										
6			2	6	14	19								
7	LIME	DDT	0	4	10	14	16	17	18				10	
8			0	7	10	10	12	13	13	14	14	15		15
9			2	5	7	8	9	10	10	11	11	13		13
10			6	9	14	14	14	14	14	14	14	15		15
11			4	8	13	14	14	14	14	14	14	14		14
12			3	3	8	9	9	9	10	11	11	12		12
13	No treatment		0	1	..	2	2	4	4	4	5	5	5	
14	Chalk alone		0	1	..	3	3	4	4	5	5	6	6	
15	Lime alone		0	1	..	3	3	3	3	3	3	4	4	
<i>Rhizopertha dominica.</i>														
1	CHALK	DDT	0	10									10	
2			0	8										
3			0	4	10									
4			10											
5			10											
6			5											
7	LIME	DDT	0	8		10							10	
8			0	2	8	10								
9			0	3	6	7	10							
10			0	2	6	8	9	9	9	9	9	9		9
11			3	5	8	9	9	9	9	9	9	9		9
12			2	4	7	7	8	8	8	8	8	8		8
13	No treatment		0	2	6	6	8	8	8	8	8	8	8	
14	Chalk alone		0	0	..	3	3	3	3	4	4	4	4	
15	Lime alone		0	1	..	2	3	3	3	4	4	4	4	



Chalk—38 mgm./sq. in.; Lime—64.7 mgm./sq. in.; Control

(mean of 13, 14, 15 in table I)

Fig. 1. Mortality of 'Calandra sp.' exposed to insecticidal wall washes.

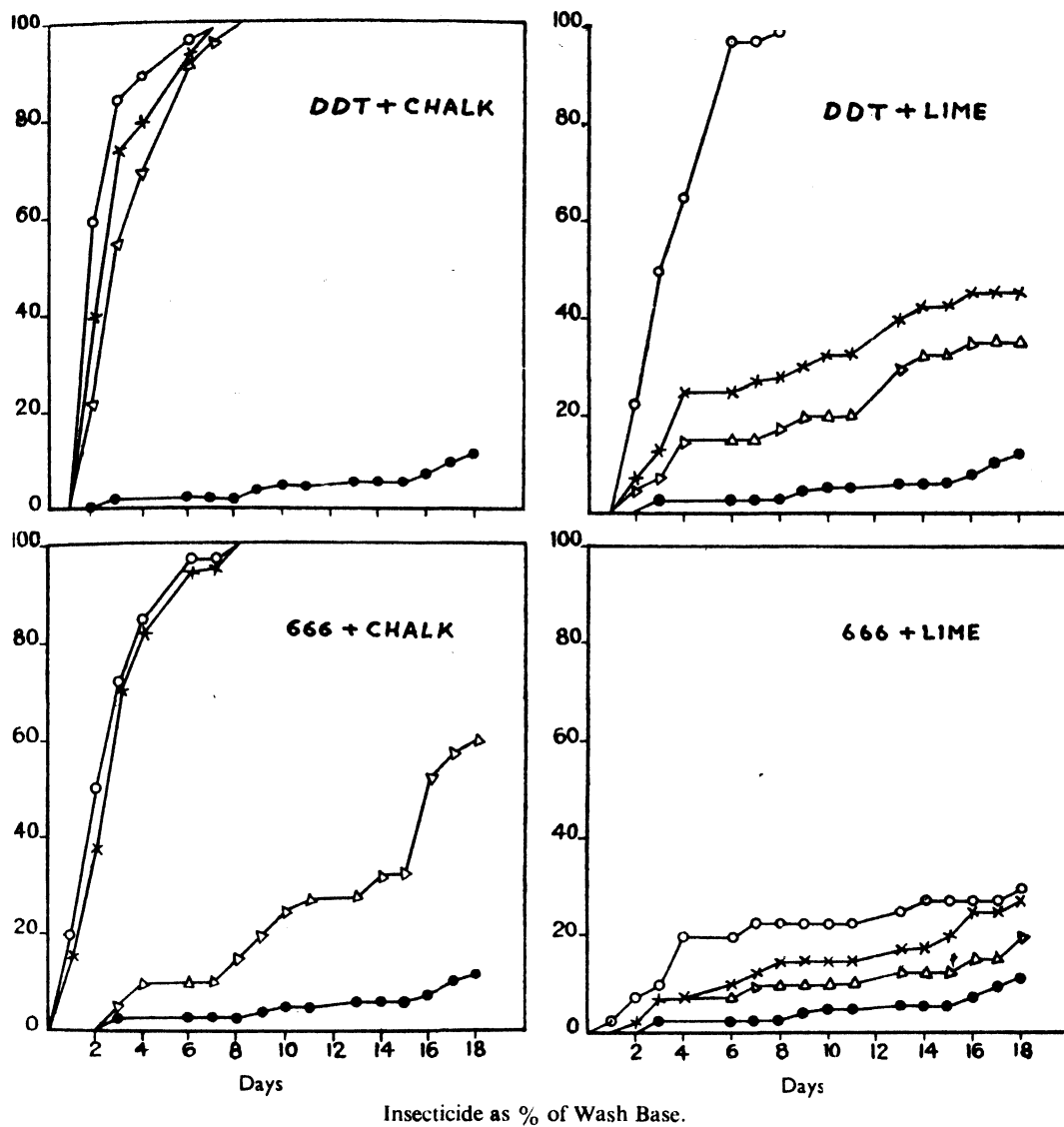
trichlorobenzene¹ and that DDT is also dehydrohalogenated by bases. The results obtained in these experiments confirm these facts and show that the rate of deactivation of 666 is faster than that of DDT.

Conclusions

DDT (85 per cent. pp' isomer) emulsion incorporated in chalk wash and applied to

concrete surfaces, kills grain pests (*Tribolium castaneum*, *Calandra sp.*, *Rhizopertha dominica*) in eight days exposure, in concentrations as low as 17.7 mgm./sq. ft. and 0.19 per cent. of the chalk.

666 is as effective as DDT against *Calandra sp.* and *Rhizopertha dominica*, but appears to be slightly less effective against *Tribolium castaneum*.



Chalk—88 mgm./sq. in.; Lime—64.7 mgm./sq. in.; Control

(mean of 13, 14, 15 in table I)

Fig. 2. Mortality of 'Tribolium castaneum' exposed to insecticidal wall washes.

Lime has a serious adverse effect on the insecticidal activity of 666, and to a lesser extent on that of DDT.

Acknowledgment

We are indebted to the Imperial Chemical

Industries (India) Ltd., for the supply of 666 (benzene hexachloride) as the crude plant product.

Reference

¹ Slade R. Benzenehexachloride. An Insecticide of outstanding properties. Hurter Memorial lecture, 1945.

THE USE OF DDT AND 666 AS INSECTICIDES AGAINST GRAIN PESTS

PART II—EFFECT OF LIME ON DDT WHEN INCORPORATED IN LIME WASH

(From the Ordnance Laboratories, Cawnpore)

Introduction

IT has been shown¹ that there is a reaction between DDT and lime when the DDT is incorporated in the form of a toluene emulsion in lime wash, and applied to cement concrete surfaces. It has been also shown that this effect is sufficient to destroy the insecticidal activity of DDT in a few days.

This paper describes a few experiments carried out to determine the nature of the deactivation process which it was assumed might take place during the mixing of the wash before it is applied, or during drying and carbonation after application.

It was presumed that the loss of insecticidal activity was essentially due to the dehydrohalogenation of the DDT to give the olefinic-dichloro compound, $(C_6H_4Cl)_2C=CCl_2$ and that this was dependent on the state of division, and dispersion of DDT in the lime wash.

Experimental

Method of mixing DDT* and Lime.—Calculated quantities of DDT, either as solid, solution or emulsion, were mixed with pure calcium hydroxide or freshly slaked lime as detailed below:—

- (i) Solid DDT mixed with calcium hydroxide in the dry state.
- (ii) Solid DDT mixed with calcium hydroxide in the presence of water.
- (iii) Same as in (ii) but allowed to dry on glazed tiles.
- (iv) An alcoholic solution of DDT mixed with calcium hydroxide paste.
- (v) An emulsion of DDT mixed with calcium hydroxide paste.
- (vi) Same as (v) but allowed to dry on glazed tiles.

Analyses of aliquots or of the whole mixture were carried out, after varying periods, by neutralizing with hydrochloric acid, extracting the DDT and estimating by determining the hydrolysable chlorine present.

* The DDT used in these experiments was pure PPI, m.p. 108° C.

The results are given in Table I.

Isolation of the degradation product of DDT when mixed with lime.—Calcium hydroxide (25 gm.) was mixed with distilled water (50 c.c.) to form a paste and to this paste DDT (0.5 gm.) in alcohol (10 c.c.) was added. The well stirred paste was kept by for seven days, neutralized with hydrochloric acid, and extracted three times with petrol ether. The ether extract was washed with water, dried over anhydrous calcium chloride and the solvent evaporated. The residue (0.42 gm.) separated in thick prisms from alcohol and had a melting point of 84.5° C. Mixed with an authentic sample of *bis* (4 chlorophenyl) dichloroethylene it had a melting point of 84.5° C.

Discussion

The variations in the DDT concentrations (See Table I) in experiments (i), (ii), (iii) and (v) are undoubtedly due to experimental error caused probably by inadequate mixing, and it can be assumed that under the conditions of these four experiments DDT is not destroyed.

DDT is, however, rapidly destroyed in experiments (iv), (iv a) and vi. In (iv) and (iv a) a solution of DDT in a water-soluble polar solvent (alcohol) was mixed with a lime slurry thereby precipitating the DDT in a fine state of division on to the lime. In experiment (vi) the DDT was dissolved in toluene, turpentine and emulsified in water. An oil-in-water emulsion of this type, on evaporation, appears to give finely divided DDT mixed thoroughly with the lime². It would appear, therefore, that the rate of degradation of DDT by lime in water wash depends largely on the size and intimacy of contact of the solid DDT and lime particles. This is also borne out by the fact that in experiment (v), where the DDT was in an emulsion and the lime mixture was not allowed to evaporate, there was very little destruction of DDT.

The isolation of the dichloro-olefine in 94 per cent. yield from the reaction between DDT and lime, and the fact that the olefine is incapable of hydrolysing any further

TABLE I. *Destruction of DDT when mixed with lime in various ways.*

Experiment No.	TREATMENT.			Amount of DDT in the reaction mixture after specified intervals of time. mgm.				Percentage DDT destroyed.	Remarks.
	Unslaked lime gm.	DDT mg.	Water cc.	hour	5 hours	24 hours	48 hours		
(i)	30.0 Ca(OH) ₂ (B.D.H.)	600 solid finely ground.	Nil.	585	550	595		Nil.	The mixture was prepared dry by grinding in a mortar and aliquots analysed.
(ii)	50.4	500 solid finely ground.	60	474	483	517		Nil.	The mixture was prepared by grinding into a paste in a mortar and aliquots (2.5 gm.) analysed.
(iii)	5.0 Ca(OH) ₂ (B.D.H.)	100 solid finely ground.	5	96.1	98.9	98		Nil.	Three such pastes were spread out on glazed tiles, allowed to dry and analysed.
(iv)	5.0	100 in alcohol.	20	94.3	75.4	15.7		85% in 24 hrs.	Three such mixtures were prepared and analysed.
(iva)	3.54	35 in alcohol.	9	31.6	24.2			32% in 5 hrs.	Same as above.
(v)	5.0	106 in emulsion.*	12	109	106		104.5	Nil.	Three such mixtures were prepared and allowed to stand wet in flasks.
(vi)	5.0	100 emulsion.*	12	99.2	49.2	35.7		65% in 24 hrs.	The pastes were spread out on glazed tiles, allowed to dry for specified times and analysed.

* Toluene, turpentine, groundnut oil.

on prolonged boiling with alcoholic potash clearly justifies the assumption that all the hydrolysable chlorine in these experiments comes from DDT.

Summary

When DDT is mixed with lime in the proportion 1 part DDT to 50 parts lime it has been shown that:—

- (1) Solid DDT ground up with lime and water does not deteriorate appreciably within 24 hours either in the wet state or when dried on glazed tiles.
- (2) DDT dispersed in lime wash in the form of an alcoholic solution decomposes rapidly.

- (3) DDT dispersed in lime in the form of an oil-in-water emulsion is stable in the wet state but decomposes on drying.

It is concluded that

- (1) The product of the reaction of DDT with lime is mainly *bis* (4 chloro phenyl) dichloroethylene.
- (2) The rate of degradation of DDT in lime washes, depends upon the state of division and intimacy of contact of DDT and lime in the aqueous mix and in the dried wash.

References

- ¹ *J. Sci. and Ind. Res.*, 1945, 4.
- ² Unpublished work.

CHEMICAL EXAMINATION OF THE SEEDS OF *MIMOSA PUDICA* LINN.

PART I—ANALYSIS OF FATTY OIL

By JOTI SARUP AGGARWAL AND KARIMULLAH

(Council of Scientific and Industrial Research, Delhi)

MIMOSA pudica Linn, commonly known as sensitive plant in English, and *Lajalu* or *Lajwanti* in Hindi, belongs to the natural order Leguminosæ. It is a native of Brazil but is found growing abundantly in the hotter parts of India.

According to Dymock, Warden and Hooper,¹ the seeds are considered in the indigenous system of medicine as resolvent, alterative and useful in diseases arising from corrupted blood and bile. In spite of the great medicinal value attached to this plant, very little work² appears to have been done on its chemistry.

The seeds of *Mimosa pudica* Linn. contain about 17 per cent. fatty oil. Detailed examination of the oil reveals that the component fatty acids are linolenic acid 0.4 per cent., linoleic acid 51 per cent., oleic acid 31 per cent., palmitic acid 8.7 per cent. and stearic acid 8.9 per cent. The unsaponifiable fraction consists of two sterols. One of them may be sitosterol while the other, not yet identified, has a melting point of 209-210° C. Further work to elucidate the character of the unsaponifiable material is in progress.

It is interesting to note that *lajwanti* seed oil resembles very closely the soya-bean oil in some important characteristics such as iodine and saponification values, and the content of the major component acids, viz., oleic and linoleic acids (Table I).

TABLE I.

Characteristics	Soya-bean Oil	<i>Lajwanti</i> Oil
Saponification value	189.5	191.2
Iodine value	128.0	130.6
Oleic acid	25.9-33.7%	31.0%
Linoleic acid	52.0-56.9%	51.0%

This oil may, therefore, find applications similar to those of soya-bean oil. Further, on account of its high linoleic and low linolenic acid contents, it may be suitable for dimerization and production of protective coating materials such as *norelac*.³

Experimental

Powdered *lajwanti* seeds were extracted

four times with ether. After removing the solvent, a greenish yellow oil was obtained in about 17 per cent. yield. The oil had the following characteristics:—

Specific gravity at 40° C.	0.9195
Viscosity at 40° C.	36 Centistokes
Refractive index at 30° C.	1.4691
Acid value	4.0
Saponification value	191.2
Iodine value (Wij)	130.6
Thiocyanogen value	74.0
Hehner value	95.0
Acetyl value	21.8
Hexabromide value	nil.
Unsaponifiable matter	2.5%
Reichert-Meissl value	0.17
Soluble fatty acids	0.6%
Saturated fatty acids (modified Bertram Method)	17.6%

Two hundred gms. of the oil were saponified with an alcoholic solution of caustic potash. The alcohol was distilled off and the soap dissolved in water. The unsaponifiable matter was removed with ether and the soap solution decomposed with dilute sulphuric acid. When heated on the water bath, the fatty acids formed a clear oily layer at the top. They were removed by extraction with ether and eventually dried under vacuum at 100° C. The fatty acids were then separated into solid and liquid acids by Twitchell's lead salt alcohol process as modified by Hilditch.⁴ The amount of liquid and solid acids present in the total fatty acids as well as their neutralization, iodine and thiocyanogen values are recorded in Table II.

TABLE II.

	Total acids	Liquid acids	Solid acids
Percentage	..	82.5	17.4
Neutralization value	201	199.0	212.6
Iodine value	131	145.9	4.0
Thiocyanogen value	81	89.4	..

Liquid Acids.—The bromine addition derivatives of the liquid acids were prepared according to the method of Eibner and Muggenthalor⁵ as described by Jamieson and Boughmann⁶. The data of the analysis

of the bromo derivatives are given below:—

Liquid acids taken for analysis	3.4872 gms.
Linolenic hexa bromide insoluble in ether	traces; not more than 0.05 gm.
Linoleic tetrabromide insoluble in petrol ether, m.p. 113-114° C.	2.69 gm.
Residue (dibromide and tetrabromide)	3.94 gm.
Bromine content of residue	44.08%
Tetrabromide in residue	46.06% or 1.81 gm.
Dibromide in residue	53.94% or 2.13 gm.
Total tetrabromide found	4.5 gm.
Linoleic acid equivalent to tetrabromide, 2.10 gm.	60.33%
Oleic acid equivalent to dibromide, 1.36 gm.	38.91%
Linolenic acid equivalent to hexabromide, not more than 0.018 gm.	0.5%

The original liquid acids were then converted into their methyl esters, and a known weight of these esters was fractionally distilled under reduced pressure as described by Hilditch⁴. The temperatures and pressures maintained during the distillation and the weights of the fractions obtained are given in Table III.

TABLE III.

Weight of esters distilled, 75 gms.

Fraction	Temp. °C.	Pressure m.m.	Weight of fraction gms.
L ₁	205-207	12.0	16.2
L ₂	207	12.0	19.4
L ₃	207-208	12.0	14.9
L ₄	208-212	15.0	6.55
L ₅	212-217	15.0	6.40
L ₆	217-227	15.0	4.6
L ₇	Residue	..	5.8
			73.85
Loss in distillation			1.15

The loss in distillation (1.15 gm.) was proportionately divided and added to each fraction. The saponification and iodine values of all the fractions were determined. The amounts of individual esters in each fraction were then calculated. The results are given in Table IV.

TABLE IV.

Fraction No.	Corrected weight gms.	Iodine value	Saponification value.	Mean molecular weight.	Weights of ester
					Methyl linoleate gms.
1	16.45	141.8	190.1	294.5	10.63
2	19.70	144.5	190.36	294.2	13.34
3	15.12	152.3	189.95	294.6	11.60
4	6.67	150.5	189.95	294.6	4.90
5	6.51	145.3	190.0	294.7	4.47
6	4.65	120.2	189.5	295.5	1.83
7	5.90	100.5	189.2	296.0	1.00
Total	75.00				47.77
					27.23

The composition of the liquid acid fraction is:—

Oleic acid	36.3 per cent.
Linoleic acid	63.6 „ „

From the above analysis it can be seen that oleic and linoleic acids are the chief constituents of the liquid acids of *lajwanti* seed oil. Linolenic acid is present only in traces. The percentages of oleic and linoleic acids were calculated also from the iodine and thiocyanogen values of liquid acids. The results obtained by various methods are given in Table V.

TABLE V.

Method	Oleic acid %	Linoleic acid %	Linolenic acid %
1. Calculated from iodine value of liquid acids	38.70	61.30	..
2. Calculated from thiocyanogen value to liquid acids	36.60	62.40	..
3. Bromination method	38.91	60.33	0.5
4. Methyl ester distillation	36.30	63.30	..

The mean values are:

Oleic acid	37.6 per cent.
Linoleic acid	61.9 „ „
Linolenic acid	0.5 „ „

Solid Acids.—The solid acids were converted into methyl esters which were distilled under reduced pressure. The various fractions collected are tabulated below:

TABLE VI.

Weight of esters distilled, 33.0 gms.

Fraction	Pressure	Temperature range °C.	Weight gm.
S ₁	12 m.m.	191-195	16.0
S ₂	12 m.m.	195-200	10.0
S ₃	12 m.m.	200-210	4.7
S ₄	Residue	..	1.5
Loss in distillation			32.2
			0.8 gm.

The loss in distillation was added proportionately to each fraction. The iodine values, saponification values and mean molecular weights of all the fractions were determined and the amounts of various acids in different fractions calculated according to the method of Jamieson and Boughmann⁶ (Table VII).

TABLE VII.

Fraction No.	Corrected weight gms.	Iodine value	Saponification value	Mean molecular weight	Weights of esters
					Methyl palmitate gms.
1	16.36	3.00	203.90	274.1	10.09
2	10.28	2.95	201.95	277.3	5.33
3	4.82	5.00	196.50	284.9	0.45
4	1.54	5.50	196.20	294.4	0.06
Total 33.00					15.93
					16.28
					0.79

The amount of individual components in the total solid acid fraction are:—

Palmitic acid	49.4 per cent.
Stearic acid	50.6 „ „

The acids from fraction S₁ on repeated crystallization from acetone gave palmitic acid, m.p. 61° C. Stearic acid m.p. 69° C. was isolated from S₃.

The fatty acids of the oil of the seeds of *lajwanti*, consists of oleic, linoleic, linolenic, palmitic and stearic acids in the following proportion:—

Oleic acid	31.0 per cent.
Linoleic acid	51.0 „ „
Linolenic acid	0.4 „ „
Palmitic acid	8.7 „ „
Stearic acid	8.9 „ „

The composition of the oil, therefore, is as follows:—

	Per cent.
Glycerides of { Oleic acid ..	30.30
{ Linoleic acid ..	49.60
{ Linolenic acid ..	0.38
{ Palmitic acid ..	8.52
{ Stearic acid ..	8.70
Unsaponifiable matter ..	2.50

References

- ¹ Dymock, Warden and Hooper; *Pharmacographia Indica*; Education Society's Press, Bombay, 1891, 1, 538.
- ² Renz, J., Z., *Physiol. chem.*, 1936, **244**, 153; Carezzo, E., *Riv. Ital. essenze profumi piante offic.*, 1934, **16**, 62.
- ³ Cowan, J. C., Lewis, A. J. and Falkenburg, L. B., *Oil and Soap*, 1944, **21**, 101.
- ⁴ Hilditch, T. P., *The Chemical Constitution of Natural Fats*, Chapman & Hall (London), 1941, 371.
- ⁵ Eibner and Muggenthalor, *Chemical Technology of Oils, Fats and Waxes*, by Lewkowitsch, 5th Edition, 1, 573.
- ⁶ Jamieson, G. S., and Boughmann, W. F., *J. Am. Chem. Soc.*, 1920, **42**, 152, 1197.

Letters to The Editor

VITAMIN B-COMPLEX IN THE TREATMENT OF DIABETES

IT was recently announced in the local

Press¹ that the vitamin B-complex has been employed as an effective agent in the treatment of diabetes. It is reported that the result was communicated to the *New York Academy of Medicine*, and it is claimed that the administration of the B-complex resulted in a substantial reduction in the insulin required for treatment; in some cases, insulin could be altogether eliminated.

A number of experiments were carried out by the undersigned in 1936 and 1937 on the use of vitamin B-complex prepared from yeast, in the treatment of diabetes. The results were communicated to the *Indian*

*Science Congress*² in 1938, and it was suggested that the B-complex preparation contained an anti-diabetic factor. The existence of such a factor has been now corroborated from other workers. The name "Adiabetin" is tentatively suggested for the new factor in the vitamin B-complex.

N. K. BASU.

Council of Scientific
and Industrial Research,
Delhi, 17th July 1945.

¹ *Hindustan Times*, July 7, 1945—The report is from the *Globe* correspondent.

² *Proceedings of the Indian Science Congress*, 1938.

Reviews

India and International Economic Policies

--A Statement. By the All-India Manufacturers' Organization, Bombay: 1944. pp. 97. Price Rs. 2-8-0.

THE Statement is a running commentary on the various items of the provisional agenda of the *International Business Conference* held in Rye, U.S.A., in November last, from what is particularly emphasized in the introduction, the standpoint of an independent India with a "real National Government . . . 'truly Indian in its outlook and sympathy,' unfettered in the exercise of its power and authority, and ready and willing to enter into such international agreements as are freely negotiated on matters—economic and political—which come within the purview of a common international authority. The various sections follow item-wise covering such subjects as maintenance of private enterprise, commercial policy of nations, currency relations, encouragement and protection of investments, industrialization in new areas, shipping policy, aviation policy, world supplies of materials and cartels.

On most of these subjects the Statement has reiterated the principles and demands which from time to time have been urged by the Nationalist Press and Indian commercial organizations, particularly in regard to the liquidation of the accumulated balances of India in sterling (by disposal of private investments of British capital in Indian industry or commerce, flotation of a dollar loan on the security of India's sterling balances, transfer of the capitalised value of the annual obligations of the Government of India in respect of pension and similar other charges payable in Great Britain, flotation of a British Government loan in India and so on); reservation of the opportunities of coastal shipping and internal aviation for exploitation to nationals of the country and *pari passu* the development of shipbuilding and aircraft industry, with necessary State support; recognition of the prior claims of a country's industry on its raw material resources, etc.

The keynote of the entire Statement is to be found in the first two sections relating to the maintenance of private enterprise and commercial policy of nations; these

set forth the basic principles which are elucidated in the remaining sections in their relevant contexts. It enunciates the premise, with certain *prima facie* evidence of historical, statistical and ideological significance, that economic progress must yet be conditioned by the maintenance of private enterprise in the initiation and operation of industries, trade and commerce,—local as well as international—and the services incidental or supplementary to such enterprise. The example of Soviet Russia with her marvellous achievements both for peace and war, within a brief period of socialist economy, is considered to be an exception to the rule. Particular attention is drawn in this connection to the equally impressive achievements of the U.S.A. which is a capitalist country *par excellence*. The dangers of exploitation in a capitalistic economy are admitted but the authors of the Statement consider that it should be possible to "cure these defects by both national and international measures."

Regarding the war-time controls and Government participation in industrial production, the Statement says that "this incursion in the economic field of State or collective enterprise in production, distribution or consumption, and this extension of the domain of public control, supervision and regulation will not be conducive to the economic progress or compatible with the fullest possible utilization of the world's available resources, if continued after the exigency of the war is over." This would, however, seem to be an enunciation of the general proposition relating to peace-time economy, for the Statement recognizes the necessity for continued State control as an essential concomitant of not only the various measures that will have to be concerted internationally to assist the transition of world economy from war to peace-time conditions, but also of the planned development of particular countries for reaching the goal of full employment and uplift of the living standards of the people. Indeed the Statement puts forward a forceful plea for international decision, backed by necessary national control, on such problems as the disposal of war surplus stores,

and the Allied lease-lend arrangements, supply of capital goods and other forms of assistance to devastated countries and also those economically underdeveloped.

International agreement is also advocated for the definition of such "Defence industries" as are to be brought under State management which, it is pointed out, would incidentally put "a check on the aggressive tendencies of selfish bellicose interests some of whom have benefited by the world being engaged in bloody wars twice in a generation." In regard to "key" industries including public utilities, effective public control is preferred to direct State enterprise "if only to ensure constant research and progress through enterprising individuals." The initiation of a planned programme of development is urged as the national desideratum for realization by each country of post-war economic ideals, but planning according to the Statement is to signify no more than a happy marriage of private enterprise with supervision, regulation and control by the State.

In regard to the commercial policy of nations the Statement takes a cue from Articles 4 and 5 of the Atlantic Charter regarding free access to raw materials of countries and fullest collaboration between all nations in the economic field and emphasizes the necessity of providing effective safeguards by way of guaranteeing the priority of national claims, particularly in respect of those underdeveloped countries, which as a matter of historical accident, have lagged behind in their industrial expansion. It is urged that the fiscal autonomy of India, as one of such countries, should not only continue unimpaired but should be made even more effective and real by reservation of certain rights and privileges entirely to the nationals of the country. This autonomy conception is pressed to the formulation of a demand that in international currency relations, India should not be treated as a mere appendage of Britain either in regard to the question of her being a member of the Sterling Block or the irrevocability of her currency being tied to the currency unit of the United Kingdom. The proposal contained in the Statement on international investment is actuated by the same principle. Foreign capital is welcome (not the foreign capitalist) but not on terms that may jeopardize the national interests of the country and

it is urged that an international agreement should be formulated on the subject providing for free movement of capital from country to country and also for safeguards in regard to the safety and security of foreign investments.

The Statement has the limited object in view of presenting certain demands of nationalist India in matters of economic policy which must not only bear the impact of international forces but would stand to gain from their recognition at an international level for being raised above the hazards of dispute and challenge or possible retaliatory reactions. Many of its points, however, would appear to have lost their force in the objective background of the decisions taken at the Bretton Woods Conference, particularly those relating to sterling balances, guarantee on international investments, delinking of the rupee and so on. Further, the aptness of introducing certain points such as those relating to the location of industries, statutory handicaps on discrimination against British firms in India, etc, in a Statement prepared for an international conference on behalf of what is presumed to be a free India with a national government, may be questioned. On the basic question of free enterprise, the argument against State enterprise is overdone in observations like the following:

"The stimulus of an increasing return or profit would be lacking in public employment. Hence in the absence of private enterprise the most possible benefit cannot be realized, whether from men or materials in any industry, utility or service and the country or community as a whole will be poorer in consequence."

This would ring as an economic anachronism even to the classical school of thought. It would be interesting to point out in this connection that even the industrial policy of the present Government of India (which does not call itself national) recently announced by the Hon'ble Member in charge of the Planning and Development Department, contains suggestions for considering the desirability of bringing quite a number of important key industries within the ambit of State enterprise. While opinions on such controversial points must naturally differ, the publication should be welcome to those interested in the study of India's economic problems.

J. N. S. G.

DEVELOPMENT OF ALLOY STEELS IN INDIA

By K. N. PRAHLAD RAO

(Tata Iron and Steel Co., Ltd., Jamshedpur).

THE word *Steel* in common usage is a general term and denotes many different kinds of steels, which are classified according to the process of manufacture, chemical composition, physical properties, method of shaping or micro-structure. The classification of steels according to use is practically impossible because of the extent and diversity of their uses. A more rational system is to grade the steels according to their chemical compositions. On this basis, there are two broad divisions of steels, viz., carbon steels and alloy steels. Carbon is the principal element which determines the physical properties of carbon steels; limited amounts of manganese and silicon are added to improve quality. Alloy steels, on the other hand, contain in addition to carbon or carbon and manganese, one or more other elements added for the purpose of imparting specific useful properties. Although a large number of elements alloy with iron, there is only a small number of them that is actually used for this purpose. They include aluminium, silicon, manganese, chromium, cobalt, nickel, molybdenum, tungsten, titanium and vanadium; and they are used in various proportions and combinations so as to produce an innumerable number of alloying systems. The effects of the alloying elements on the properties of iron, particularly in the presence of carbon, have been studied in great detail. Generally speaking, they impart greater strength without affecting the ductility, which characterizes carbon steels, or give rise to special properties such as resistance to corrosion and to heat, ability to cut other metals at high speeds, high magnetic permeability and retentivity, etc.

Modern engineering practice demands constructional materials which should withstand high degrees of stresses with a great degree of safety under severe working conditions. Advances in automobile and aircraft building, as well as the less spectacular, but no less important, developments in general engineering practice, have rendered specialization in the quality steel industry both necessary and imperative.

There are two general sub-divisions of alloy steels. The first covers the range of

low alloy steels which include a large number of engineering steels; and the second covers the range of high alloy steels for tools and special purposes.

Low Alloy Steels

The low alloy steels can be further subdivided into structural steels and machinery (constructional) steels. A large group of steels under the latter category is used for highly stressed machinery parts such as shafts and gears, and for the construction of automobiles and aircrafts. They are generally alloyed with one or more of the common alloying elements like nickel, chromium, silicon, manganese, molybdenum and vanadium. They have to be heat-treated for the optimum development of strength, hardness and ductility.

The low (mild) alloy high strength structural steels have been developed to meet the requirements of loaded structures. They are generally used without any heat treatment, in contrast to the tool steels which have to be invariably heat-treated before putting them into service.

In engineering practice, the property essential for the design of any structure is the modulus of elasticity, as this property determines the stress-strain relationship in a member. In addition to the high strength, other useful properties that are desirable are: welding characteristics, resistance to atmospheric corrosion and good ductility. The obvious advantage that can be derived from the low alloy high tensile steels is the reduction in weight and the economics that can be effected thereby. For instance, for a given load, either a lighter section can be used or the same section could be used to stand a heavier load, if this is necessary.

The development of low alloy, high tensile steels has advanced considerably in America, Germany and Great Britain. America and Germany have concentrated on the development of structural steels with a high yield strength whereas in Great Britain, a high ultimate strength with good ductility has been the aim.

Tiscor and Tiscrom

High tensile steels which correspond to the American high yield strength, corrosion resistant structural steels, as well as the high tensile English steels have been developed in India by the *Tata Iron and Steel Co.* The former type is marketed under the name of TISCOR and the latter as TISCROM. Tiscor is essentially a chromium-copper-silicon-phosphorus steel of low carbon content. The superiority of this material as compared to ordinary carbon structural steels will be apparent from Table I.

TABLE I.

	Ordinary mild steel (B.S.15)	TISCOR
Tensile strength, tons/sq. in.	28 min.	31 min.
Yield point, tons/sq. in.	14 min. (approx.)	22 min.
Elongation, % on 8 inch.	20 min.	20 min.
Resistance to atmospheric corrosion	1	4 (approx.)

Tiscor is ductile and is easy to fabricate. It can be welded satisfactorily and resists atmospheric corrosion three to four times better than mild steel. It has been shown that 20 to 50 per cent. reduction in weight can be effected by employing this quality steel. Tiscor steel is an ideal material of construction for transport vehicles, including railway wagons, motor trucks, ships, mine tubs, etc.

Tiscrom which is a chrome-manganese-copper, high tensile structural steel fully satisfies the requirements of the *British Standard Specification 548-34*, which calls for a maximum stress of 37 to 43 tons per sq. in. This steel is corrosion-resistant, has a high fatigue limit with high tensile strength and good ductility. The safe working stress of the steel is approximately 50 per cent. higher than that of plain carbon steel. As light-weight high tensile structures are more economical in the long run, this low alloy structural steel has been widely used for the construction of bridges, structural framework, wagons, ships, etc. An outstanding example of its use is the incorporation of about 17,000 tons of tiscrom steel in the construction of the New Howrah Bridge which spans the Hooghly at Calcutta—the third largest cantilever bridge in the world.

The development of low alloy engineering steels has been governed by such considerations as the relative importance of strength, hardness and toughness which the machine parts have to possess. Carbon steels, whilst providing a fair range of mechanical properties, are not suitable for highly stressed parts

—particularly of non-uniform shape, as they are susceptible to non-uniform hardening with its inherent internal stress, distortion and unsatisfactory ductility.

The addition of alloying elements imparts a wider range of properties and a better combination of strength with ductility. The maximum effect of alloying elements are obtained only in the heat-treated condition and, therefore, the low alloy machinery (constructional) steels which cover a wide field of application, require to be heat-treated for obtaining the maximum service. Table II gives the compositions and application of the more important types.

High Alloy Steels

High alloy steels find their largest use in the manufacture of tools and equipment which call for properties such as wear resistance, hardness, high strength combined with toughness, etc. A large variety of steels with special properties such as low and high coefficient of expansion, magnetization, heat and corrosion resistance, have been developed. The quantities and the kind of alloying elements used in the manufacture and the subsequent treatment that such alloy steels have to undergo, decide to a large extent the nature and application of these steels.

The scarcity of steel alloying elements being not so acute before the war, there was no limit to the number of compositions the metallurgist could make and the amounts of the various alloying elements that he could judiciously add. But with the outbreak of the war, conditions changed entirely. Transshipment of ores from one country to another became difficult. To meet the shortage of essential raw materials and the unprecedented demands, the manifold compositions of alloy steels had to be cut down and quantities of the alloying elements restricted, consistent with the properties required. Due to a more thorough approach to the fundamentals of the subject, newer and stronger alloy steels have been developed.

Committees were set up both in the U.K. and in America, comprising specialists in alloy steels, to work out a list of steels that could be produced with a minimum of alloying elements. As a result of the labours of the Committees, the *T.A.C.* specifications and *British Standard Emergency Specification B.S.970* were developed in England and the

TABLE II.

Steel	C.	Ni.	Cr.	Mo.	Uses.
2% Nickel steel	0.15	2.20	0.25	..	Case hardening parts liable to shock.
5-6% Nickel steel	0.20	5.50	0.25	..	Large parts, subject to severe stresses.
Nickel-chrome steel	0.18	3.0	0.75	0.15	Parts, case hardened or not, requiring great strength.
Nickel-chrome-molybdenum steel	0.40	1.6	1.00	0.2-0.3	All important mechanical parts.
Nickel-chrome-molybdenum steel	0.40	3.0	0.95	0.4-0.5	Normalized for strong machined parts quenched and tempered for highly-stressed parts.

National Emergency steels in America. More than 2,000 specifications that were in vogue were cut down to 85; the *B. S. Emergency Specification 970* includes some 58 standardized varieties. The special feature of these specifications is that they envisage the greater use of plain carbon steels and the use of an increased percentage of manganese.

While the emphasis has been shifted to the economizing of known alloying elements and to make a more fundamental study of the behaviour of alloys with a view to finding new uses for them, it has been discovered that certain elements hitherto little used, impart marked effects which may revolutionize the future of alloy steels. Experiments have revealed that a few thousandths of 1 per cent. of boron produces very marked changes in steel properties and particularly, the hardenability of the material. Extensive use of boron steels is made in many engineering applications. Similarly, zirconium, selenium, titanium, etc., have all been used to supplant and take the load off other alloying elements, and at the same time, to impart improved properties. Molybdenum has been used as an effective substitute for tungsten in high speed steels to a considerable extent. A new range of high speed steels has thus been initiated which will persist and perhaps expand in the post-war period of industrial development.

Lead does not alloy with steel, but lead-bearing steels have been developed which can be machined with 50 per cent. greater speed, the other physical properties being unaffected. By the incorporation of sulphur and selenium, machinability of steels can be greatly enhanced, and new types of free cutting steels have come into regular use.

The Indian Steel Industry

The Indian steel industry before the war had confined itself chiefly to the manufacture of ordinary mild steels by the basic open hearth process. The manufacture of special grade high quality steels was practically non-existent, but for a small-scale attempt

by the electric furnace foundries and ordnance factories. With the outbreak of the war, conditions changed considerably and demands were made on *Tata Iron and Steel Co.*, the principal steel producer in the country, to supply steels that covered practically the entire range, from straight carbon tool steels to the high quality aircraft steels. Almost all the varieties of steels used in general engineering practice and machine construction, such as high speed steels, hot die steels, tap steels, nickel-chrome steels, special steels for shear blades and punches, etc., have been developed. To meet the urgent requirements of the mints, die steels have also been produced in bulk.

The compositions of a few important alloy steels manufactured by the *Tata Iron and Steel Co.* are given in Table III.

In addition to the demand for tool steels and alloy steels for civil uses, special alloy steel products for direct war demands such as bullet-proof plates and rivet bars, special quality welding rods for the welding of bullet-proof plates, chrome-nickel-molybdenum steels for parachute and statichute harness fittings, chrome-molybdenum steels for armour-piercing shots, nickel-manganese non-magnetic steels for service helmets, and a number of other types have been successfully developed.

It may be of interest to note that Indian-made bullet-proof plates have been tested and found to be as good as those made in other countries. The armoured cars built in India did magnificent service in the Eighth Army's forward drive in North Africa. It has been recorded that while an officer was moving his observation post forward, a 75-mm. shell burst on one side of his *Tatanagar* which buckled the bullet-proof plates but could not pierce through them. Many lives have been saved from shelling and bombing by the effective protection offered by bullet-proof plates made in India. Practically all the varieties of special aircraft steels as specified by *War Emergency British Standard Schedule 970* are now regularly produced. The range of steels included in the

TABLE III.

Quality	C.	Mn.	Si.	S. & P.	Cr.	Va.	W.	Ni.	Co.
Cobalt high speed	0.77	0.30	..	..	4.00	1.00	21.0	..	11.50
	0.85	0.40	..	..	4.75	1.50	22.0	..	12.50
Do.	0.70	0.20	..	..	4.25	1.00	18.0	..	5.00
	0.80	0.30	..	..	4.75	1.50	19.0	..	6.00
Tungsten high speed	0.70	0.15	..	..	4.00	1.00	18.0	..	..
	0.80	0.30	..	..	4.75	1.50	19.0	..	..
Do.	0.60	0.15	..	..	3.50	0.50	14.0	..	..
	0.70	0.30	..	..	4.20	0.80	15.0	..	..
Die steel	0.55	0.50	0.30	0.05	0.30	..	..	1.00	..
	0.65	0.80	max.	max.	max.	..	..	1.50	..
Do.	0.40	0.65	0.20	0.05	0.75	..	..	..	..
	0.50	0.85	max.	max.	1.00	..	..	..	..
Hot die steels	0.28	0.30	0.30	0.03	3.00	0.25	8.0	..	..
	0.40	max.	max.	max.	4.00	..	10.5	..	..
Drawing die steel	1.30	0.40	0.30	0.04	0.80	..	3.75	..	..
	1.50	0.60	max.	max.	1.00	..	4.50	..	..
Tap steel	1.10	0.40	0.30	0.03	0.45	..	..	..	..
	1.30	max.	max.	max.	max.	..	1.25	..	..
							1.50	..	..
Pneumatic steel	0.40	0.10	0.50	..	1.00	..	2.0	..	..
	0.45	0.25	0.70	..	1.20	..	2.5	..	..
Shear blade steel	0.85	0.25	0.30	0.035	10.00	0.15	..	0.20	..
	0.95	0.40	max.	max.	12.00	0.35	..	0.30	..
						(opt.)	..	..	..
Punch steel	0.40	0.25	1.00	..	1.00	..	1.75	..	..
	0.45	..	1.50	..	1.50	..	2.00	..	..

TABLE IV. *Stainless steels.*

Type	C.	Mn.	Si.	Ni.	Cr.
S. 80	0.15-0.25	1.0 max.	0.50 max.	1.5-2.0	16.0-20.0
Cutlery type	0.30-0.35	0.20-0.40	0.20-0.40	..	12-14
Engineering quality	0.15-0.25	0.20-0.40	0.20-0.40	..	12-14
Austenetic type	0.15 max.	0.50-0.80	0.5 min.	8-9	18-20
			(Wo. 3% opt.)	..	..
Heat-resisting quality	0.18	..	..	25.0	20.0

schedule cover free cutting steels, plain and alloy case carburizing steels, manganese-molybdenum steels, nickel-chrome-molybdenum steels, high nickel-chrome-tungsten valve steel, straight chromium and nickel-chromium rust-resisting steels, etc. To meet the demands of certain specialized departments, new varieties of steels such as telephone wires, high tensile wires, welding electrode wires, wire drawing plates, etc., have been produced.

For the manufacture of cutlery, surgical instruments and equipment for the chemical and engineering industries, stainless steels of different compositions have been made by the *Tata Iron and Steel Co.* Table IV gives the approximate compositions of the different grades.

Researches on the manufacture of permanent magnet steels utilizing indigenous raw materials is under way. Chromiummagnet steels have been produced against the demands of the Post and Telegraph Department. Cobalt and other types of magnet steels have been made for uses in field compasses and electrical instruments.

Apart from the wide range of alloy steels that have been developed and supplied as rolled bars, plates, sheets, etc., several alloyed steel castings for special service requirements have been made. High manganese austenetic steel castings (13 per cent. Mn.) have been made for machinery parts such as

crusher jaws, dredger bucket tips, etc., where severe wear resistance is called for. A modification of this type of steel with 4 per cent. nickel and 10 per cent. manganese has been developed; this composition facilitates fabrication and does not require heat treatment after manufacture. High silicon (14.0 per cent. Si.) iron for acid-resisting castings have been made and also highly alloyed nickel-chrome heat-resisting steel for charcoal gas producer steam nozzles.

Another aspect of the war-time development of the steel industry is the production of ferro-alloys essential for alloy steel manufacture. Ferro-manganese was being made in large quantities even before the war, but ferro-silicon, ferro-tungsten, ferro-vanadium, ferro-titanium and silico-manganese have been successfully made from indigenous raw materials, during the war period.

The foregoing brief survey of the development of alloy and tool steel industry in India will give some idea of the start that has been made under the stress of war conditions and at a time when essential equipment and technical assistance was very limited. The experience gained makes further progress easy, and when conditions improve, Indian industries who have all along depended on foreign imports for alloy and tool steels can obtain their requirements in the country itself.

MANUFACTURE OF WIRELESS APPARATUS IN INDIA *

By S. P. CHAKRAVARTI

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UNLIKE the Western countries, India manufactures very little of the wireless apparatus worth mentioning; what she actually produces may be considered negligible in relation to her actual demands. There is *more* of the assembly of imported parts and components than the actual manufacture. The number of items assembled is also limited. The well-known items on the list of assemblies are:

- (1) wireless receiving sets (of straight and super-heterodyne types) for broadcast reception,
- (2) wireless communication receivers, and
- (3) public address amplifiers.

The other items which have probably been, or are assembled in very small quantities from time to time by certain radio concerns in big towns are:

- (1) wireless telephone and telegraph transmitters of low power,
- (2) wireless trans-receivers, and
- (3) audio and radio frequency oscillators.

The above form the only radio items which have ever been, or are being assembled from radio parts and components imported from foreign countries, as well as those manufactured in India on a small scale. As the manufacture of complete wireless apparatus in India is bound up with the manufacture of a few hundreds of essential basic parts and components, it is desirable to consider fully the manufacturing position of the fundamental items.

History

The growth of radio in India may be said to have started in the year 1926, when two low-power broadcast transmitters operating in the medium wave band were installed at Bombay and Calcutta under company management. The closing months of 1927 saw the establishment of the radio telegraph link working on the beam principle between India and Great Britain and the merging of the radio and cable interests. This was followed by the opening of a second radio telephone link between India and Great Britain in 1932 and a third radio telegraph

link between India and Japan in 1933.

The inauguration of the broadcasting service enlisted a large number of listeners in Bombay, Calcutta and other places. It created a band of amateur technicians who interested themselves in building up sets, improving reception and studying numerous other technical problems. Some of the amateurs were not satisfied merely with the reception of radio signals from Indian and foreign stations, but desired to exchange messages among themselves. A good number of amateur transmitting stations, therefore, came on the air, and those who were granted transmitting licences became potential radio technicians who devoted their time and energy wholly to the problems of transmission and reception. The advantage of employing the public address systems at meetings and in auditoria also began to be realized in this country from about 1929.

These developments no doubt gave a strong impetus to the manufacture of radio parts and components, complete receiving and transmitting sets and public address amplifiers in India; but the prospective capitalists were not impressed with the number of broadcast listeners and transmitting licence holders in the country and could not foresee, at that stage, how far the broadcasting service in India was likely to develop in the near future. They had also doubts as to whether the radio industry in India would be able to turn out products of the desired standard at a suitable price which could compete with the imported ones. Therefore, instead of taking up the actual manufacture, many concerns in Bombay, Calcutta and other Indian cities began assembling straight receiving sets, low power radio transmitters and audio amplifiers from parts and components imported from foreign countries. Some of the receiving sets assembled in India presented an external appearance not inferior to that of the high grade British, Continental and American products and were sold to the public at high prices. The majority of people in Bombay and Calcutta were

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor, 20, Pusa Road, New Delhi.

content to pick up the local medium wave station and were satisfied with the India-made straight receiving sets; others who were interested in foreign stations as well went in for better sets of foreign make. This state of affairs continued for a period of about seven years from 1926 to 1933, and during this time a total of at least 5,000 to 6,000 receiving sets must have been assembled per year in all the big Indian cities taken together, although exact figures are unavailable.

The period 1933-39 saw great developments in broadcasting in different countries of the world. A large number of high power broadcast transmitters operating in the medium and long wave bands were installed in Great Britain and on the continent, and many European countries organized overseas broadcast services on short wavelengths. Upto 1936, there were only three medium wave stations in India, one at Bombay, a second one at Calcutta and the third one at Delhi (with additional low power short-wave transmitters at Calcutta and Bombay) under the administrative and technical control of the Indian Posts and Telegraphs Department.

Since 1936, broadcasting in India has been reorganized on progressive lines. A separate Department of Broadcasting known as the *All India Radio* has been started with a Controller of Broadcasting (name changed to Director-General, All India Radio, in 1944) as its administrative head and a Chief Engineer as the head of its engineering and technical side. The main problem before the new Department was to organize a suitable broadcasting service for the whole country with the limited sum of about 40 lakhs of rupees placed at its disposal. This was solved by adopting the policy of giving a second grade short-wave service, both day and night, to the whole of the country and a first grade medium-wave service over the principal town areas, the latter type of service to be developed as more funds became available.

Considerable progress was made abroad in the development of radio broadcast receivers during the 10-year period 1929 to 1939, the chief features of which were the almost complete supersession of the straight receiver by the super-heterodyne type and the increase in the number of accessory circuits. Design was influenced to a great extent by the fact that the sales market had consisted of a large majority of purchasers of first receivers. This tended to

over-emphasize the accessory circuits (which can be made a good selling point) at the expense of the basic design. Foreign super-heterodyne sets with better performance began to pour into the Indian market. Large numbers of Indian listeners who had developed a liking for listening to foreign stations radiating on short and medium wavelengths, and who also desired to pick up Indian short-wave stations, purchased these sets.

The advent of short-wave broadcasting in India encouraged many Indian concerns to assemble super-heterodyne radio receivers so as to bring their price within the means of the majority of listeners. During the period 1932-39, certain parts and components like power transformers, I.F. transformers, intervalve transformers, output transformers, chokes, H.F. coils, fixed and variable condensers, trimmers and padders, knobs, switches, etc., began to be manufactured on a small scale in this country and a large number of super-heterodyne sets assembled in India incorporated these parts with imported tubes, loudspeakers and electrolytic condensers.

In the year 1939, a typical manufacturer at Calcutta (*Bose's Radio Laboratory*) put on the market a few models of super-heterodyne radio receivers of the following descriptions:—

- (1) *Model NC-511*.—5-tube AC/DC All Wave Receiver, covering three wave bands 13.6 to 550 metres; 6" permo-speaker; square plane illuminated dial with the important stations marked; continuously variable tone control and pick-up connection; undistorted audio output about 3 watts; selling price Rs. 250.
- (2) *Model NC-811*.—8-tube AC/DC All World Receiver, covering three wave bands 13.6 to 550 metres; magic eye; pushpull output; two speed dial with stations marked; variable tone control and pick-up connection; tuning indicator indicating stations; other features and cabinet similar to those of *Model NC-511*; undistorted audio output about 4.5 watts; selling price Rs. 375.
- (3) *Model NC-611*.—5-tube AC/DC All India Compact Receiver; two wave bands 25 to 550 metres; 5" permo-speaker; clock-face illuminated dial; dial lamps indicating bands; undistorted audio output about 2 watts; selling price Rs. 180.

5 VALVE A.C.-D.C. RECEIVER
MODEL NO.-NC/511
CHASIS NO.-4005
SENSITIVITY CHARACTERISTIC
(MEDIUM WAVE BAND)
200-500M

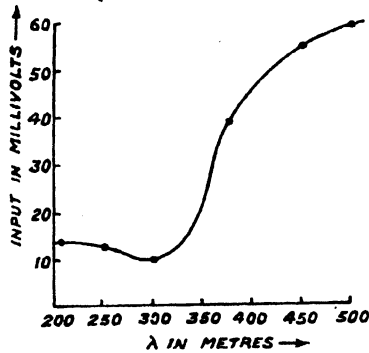


Fig. 1

5 VALVE A.C.-D.C. RECEIVER
MODEL NO.- NC/511
CHASIS NO.- 4005
SENSITIVITY CHARACTERISTIC
(SHORT WAVE BAND)
30M - 70M

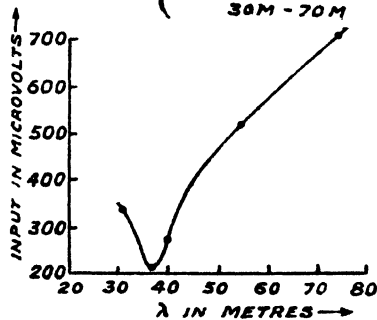


Fig. 2

5 VALVE A.C.-D.C. RECEIVER
MODEL NO.- NC/511
CHASIS NO.- 4005
SENSITIVITY CHARACTERISTIC
(SHORT WAVE BAND)
12M - 30M

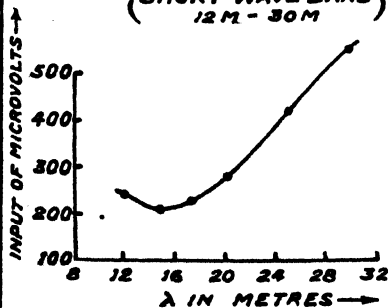


Fig. 3

The sensitivity, selectivity and electric fidelity characteristics of the model NC-511, five-tube, three bands, AC/DC super-heterodyne receiver (chassis No. 4005), as measured at the *Kanodia Electrical Communication Engineering Laboratories*, University of Calcutta, and incorporated in the Certificate of Examination dated 2nd September 1940 issued to the manufacturers by the Calcutta University, are shown in Figs. 1-5. The manufacturing costs of the above models could not exceed one-third of the selling (retail) prices shown. It will be noted that a lower manufacturing price was not possible as tubes, loudspeakers and one or two other components employed were imported from foreign countries. A few Bombay concerns like *Evergreen Radio Corporation* were also known to assemble super-heterodyne radio receivers from parts and components imported from abroad. All India Radio experimented on the development of suitable radio receivers for community listening in rural broadcasting.

With the outbreak of the war in September 1939, and subsequently with the entry of Japan into the conflagration in 1941, the position relating to the assembly of radio sets from parts and components imported from the United Kingdom, the continent of Europe, the United States and Canada became gradually worse. During the first two years of the war, a limited number of radio receiving sets was assembled; but subsequently the imported radio parts and components, as also complete sets, became scarce. The assembly of radio sets and other radio equipments had to be abandoned by many concerns. The development and manufacture of the basic parts and components were taken up more seriously.

In April 1942 the production of radio sets in the United States of America for civil consumption at home and abroad, was stopped. The Government of India imported about 41,000 radio sets (*Philips*, *R.C.A.* and *Westinghouse*) according to their specifications, as well as sufficient quantity of parts and components for the maintenance of the sets. These were distributed to the normal trade channels, Defence Department, Information and Broadcasting Department, Labour Department, Provincial Governments, Indian States, U.S.A. Forces, etc.

A systematic examination of the manufacturing position relating to radio components and equipments in this country was taken up early in 1942, probably for the

first time, by the Government of India in connection with the development of military radio sets. Investigations leading to the development of certain parts and components from materials available in India have since been carried out under the auspices of the Radio Research Committee of the Board of Scientific and Industrial Research. It is now known that sufficient facilities for the manufacture of all parts and components excepting tubes (valves) exist in India, and that the concerns possessing manufacturing equipments are in urgent need of special basic materials and appliances.

Present Position

At the present moment, so far as information is available there are about 18 Indian concerns (Table I) which have been manufacturing, or are in a position to undertake the manufacture of radio parts, and accessories components excepting valves. Some of them are known to assemble complete broadcast receiving sets and/or audio amplifiers. It will be noted that some of the concerns in the list are mainly manufacturing ones, while others are mainly sales organizations. A few of them are also not exclusively devoted to the development and manufacture of radio parts, components and accessories. It has been known recently that one concern at Bombay, another at Madras, and a third one at Bangalore will start manufacture of sets and components very soon.

In addition, some of the University Post-graduate Departments, like the Departments of Pure Physics and Applied Physics of the Calcutta University, and the Department of Electrical Technology of the Indian Institute of Science, Bangalore, have developed and manufactured, on a small scale, radio components like carbon and vitreous enamelled wire-wound resistors, mica and tubular paper condensers, variable air condensers, loudspeakers, microphones and vibrators. There are a number of electric lamp (bulb) manufacturing concerns in the country, both in the North and the South, and it is likely that some of them may be willing to take up the manufacture of valves.

Out of the 25 concerns given in Table I, Nos. 23 and 24 are Government concerns and the rest are purely Indian public or private enterprises. It has not been possible to ascertain the capital invested in each of the 23 concerns, but it may be said that the total authorized capital of all of them will not probably exceed 500 lakhs of rupees.

**5 VALVE A.C.-D.C. RECEIVER
MODEL NO.-NC/511
CHASIS NO.-4005
SELECTIVITY CHARACTERISTIC
(SHORT WAVE BAND)**

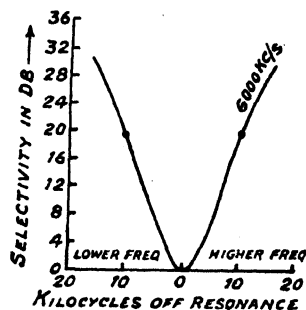


Fig. 4

**5 VALVE A.C.-D.C. RECEIVER
MODEL NO.-NC/511
CHASIS NO.-4005
SELECTIVITY CHARACTERISTIC
(MEDIUM WAVE BAND)**

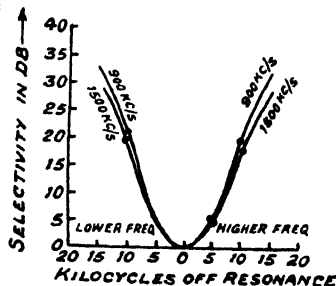


Fig. 4

**5 VALVE A.C.-D.C. RECEIVER
MODEL NO.-NC/511
CHASIS NO.-4005
FEDELITY CHARACTERISTIC
(CARRIER FREQUENCY-1000 KC/S)**

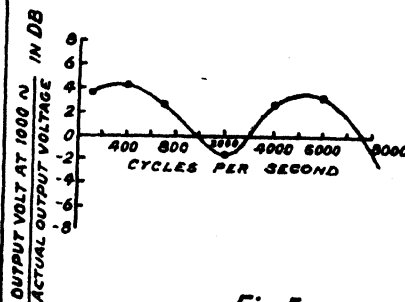


Fig. 5

TABLE I.

No.	Location	Concerns	Activities
1	Calcutta.	<i>Indian Cable Co., Ltd.</i>	Manufacturing.
2		<i>Radio Supply Stores</i>	Sales/manufacturing/ assembly.
3		<i>Hindustan Musical Products and Variety Ltd.</i>	Do.
4		<i>Bose's Radio Laboratory</i>	Manufacturing/assembly.
5		<i>G. Rogers & Co.</i>	Sales/assembly.
6		<i>Bharat Battery Manufacturing Co.</i>	Manufacturing.
7		<i>National Battery Manufacturing concern.</i>	Do.
8	Bombay	<i>Electrical Storage Co.</i>	Do.
9		<i>National Carbon Co., Ltd.</i>	Do.
10		<i>National Radio & Engineering Co.</i>	Do.
11		<i>Hindustan Construction Co. (Radio Section) (Hindustan Radio Products)</i>	Do.
12		<i>Evergreen Radio Corporation</i>	Assembly/sales.
13		<i>Fazalbhoy Ltd.</i>	Sales/assembly.
14		<i>Chicago Radio & Telephone Co.</i>	Sales/assembly/manufacturing.
15	Delhi.	<i>Saba Radio Co.</i>	Sales/assembly.
16		<i>Estrella Batteries Ltd.</i>	Manufacturing.
17		<i>Globe Radio and Engineering Co.</i>	Manufacturing assembly/ sales.
18	Lahore.	<i>Rama Radio Manufacturing Co.</i>	Assembly/sales.
19		<i>Parco.</i>	Do.
20	Lucknow.	<i>Wireless House</i>	Do.
21		<i>United Radio and Engineering Corporation.</i>	Sales/manufacturing.
22	Coimbatore.	<i>U.M.S. Radio Factory.*</i>	Manufacturing.
23	Bangalore.	<i>Government Porcelain Factory.</i>	Do.
24		<i>Government Electric Factory.</i>	Do.
25		<i>Amco Ltd.</i>	Do.

* (Probably not functioning in 1945.)

The labour employed for the development, manufacture and assembly in each of the 23 concerns is Indian. It has not been possible to give figures for the number of workers employed per day in each of them, but the following information relating to one fairly large manufacturing concern*—*U. M. S. Radio Factory, Coimbatore*, may be of some interest. About 30 to 40 workers were employed per day in the past years. Some of the heavy works like casting, punching, die-making, etc., were done in an allied factory—*Messrs. National Electric Works Ltd., Coimbatore*, on behalf of the *U. M. S. Radio Factory*.

Raw and/or Basic Materials

The principal raw and/or basic materials needed for the manufacture of the radio parts and components which have been, or are being developed, are given below.† The basic materials for the manufacture of valves, which have yet to be taken up, are shown separately under "Future Developments."

(1) *Metals and allied materials*.—Silver and gold-silver for vibrator contacts, copper, iron (soft iron), steel, magnet-steel (for permanent magnet), stalloy, manganese, chromium, cobalt, nickel, uranium, tin, lead,

* Information obtained from the Radio Engineer, Provincial Broadcasting, Madras.

† Portion of information obtained from "Report on the present position regarding radio set manufacture" (Radio Research Committee).

graphite, aluminium, zinc, tin and copper foils, aluminium foils (1 to 4 mils. thick and 99.95 per cent. pure), aluminium sheet (3 mils. thick and of lesser purity), aluminium framework, copper wires (of gauges s.w.g. 38 and upwards) and Litz wires.

(2) *Alloys*.—Eureka, nichrome, manganin, phosphor bronze, brass, cold rolled phosphor bronze, brass sheets and lead-tin alloy.

(3) *Ordinary insulating materials*.—Silk, cotton, rubber, insulating enamels, impregnating compounds, wax, porcelain, bakelite moulding powder (or shellac moulding powder), mica, pitch, resin, insulins, insulating sleeveings, leatheroit paper, empire cloth and ebonite.

(4) *Low-loss H.F. insulating materials*.—H.F. porcelain (steatite, isolantite), bakelite moulding powder, laminated insulating boards (paxolin, dilecto) and sealing compounds.

(5) *Adhesives, varnishes and chemicals*.—Cameron glue, casein glue, dextrine paste and solution, casein paste, durofix, golden lacquer, steatite slab, boric acid and salts, cadmium salts, aquadag.

(6) *Miscellaneous materials*.—Thin kraft paper (0.5 to 2 mils. thick), tissue paper, suitable paper and paper-pulp for loud-speaker cones, pressboard, press-pahn paper, rubber latex, carbon electrodes for dry batteries, sand, talc, asbestos pulp, plastics and suitable kinds of wood for cabinet.

All items mentioned under (1), (2), (3), (4), (5) and (6) except about sixteen of them are either readily available, or are being developed in the country. Eleven out of the sixteen items can be produced in India after some investigation, whereas the remaining five are either to be imported or special manufacturing equipments have to be imported from abroad.

The items under the above sub-heads which can be produced after some investigation are:

Metals and allied materials. (i) *Magnet steels*.—Some quantity of magnet steel (6 per cent. tungsten) has been manufactured by *Messrs. Tata Iron and Steel Co., Ltd.*, the

test results are not available. (ii) *Stalloy*.—Recently electrical sheet steel (about 4 per cent. silicon) has been produced on an experimental scale by Messrs. *Tata Iron and Steel Co., Ltd.*, to be used in place of stalloy. The performance of the sheets has been carefully studied by the Department of Electrical Technology, Indian Institute of Science, Bangalore, and reported to the Metals Committee (*B.S.I.R.*)

Alloys.—(i) *Eureka*, (ii) *nichrome* and (iii) *manganin*.—A scheme of research on the production of these alloys is being worked out under the *Board of Scientific and Industrial Research*. The results are not yet available.

Ordinary insulating materials. *Insulating enamels*.—It is understood that experiments have been, or are being, carried out on *Philwan Resin*—a product extracted in the laboratories of the Director, Scientific and Industrial Research, to ascertain its suitability as enamel coating on metallic conductors for electrical insulation.

Low-loss H.F. insulating materials. (i) *Bakelite moulding powder*.—The *Bhadravati Iron Works* in Mysore have produced a powder in small quantities and bakelite goods have been manufactured out of it. It is understood that steps have been taken to test the suitability of this product for use in radio components. Several types of powders have also been produced in the Laboratories of the Director, Scientific and Industrial Research, and some of them are likely to prove suitable for use in radio components. (ii) *Low-loss porcelain*.—The *Government Porcelain Factory, Bangalore*, has produced a type of porcelain which has been tested and found satisfactory for high frequency work. It is likely that this factory will be able to manufacture materials like steatite, isolantite, etc., if samples of such substances are supplied to them. (iii) *Low-loss laminated insulating boards*.—Various types of laminated paper and cloth boards have already been produced in the Laboratories of the Director, Scientific and Industrial Research. Preliminary tests show that although they are not so good as *dilecto* or *paxolin* at high frequencies, they can be improved and employed in radio parts and components.

Adhesives, varnishes and chemicals.—*Aquadag* is required for fixing the film deposit on to the supporting strip in the case of deposited film type volume controls, but it is not available at present. There should be no difficulty in producing this material after some investigation.

Miscellaneous materials. *Special paper and paper-pulp cones*.—Loudspeaker cones from special paper manufactured by the *Titagarh Paper Mills* have been developed in the *Kanodia Electrical Communication Engineering Laboratories*, University of Calcutta. Paper-pulp cones have been developed in the Department of Physics of the Calcutta University. A large number of loudspeakers fitted with both types of cones have been successfully manufactured.

National Radio and Engineering Co., Bombay, have developed a large number of cones for use in loudspeakers.

The five items which are either to be imported or for which special manufacturing equipments have to be imported from abroad are:

Wires of s.w.g. 38 and higher.—These wires cannot be manufactured in India with the existing equipment. *U.M.S. Radio Factory, Coimbatore* and *Government Electric Factory, Bangalore*, can manufacture them provided suitable diamond dies for drawing such thin gauge wires are obtained from abroad.

Litz wires.—*U.M.S. Radio Factory, Coimbatore*, can manufacture Litz wires if diamond dies suitable for drawing thin wires (s.w.g. 44) are obtained from abroad.

Tin and copper foils.—(1 to 4 mils. thick), *aluminium foils*: (1 to 4 mils. thick and 99.95 per cent. pure) and *thin kraft papers*: (0.5 to 2 mils. thick) have to be imported from abroad.

Manufacturing Processes

The manufacturing process relating to a component has varied more or less with the firm or the institution where it has been developed. All processes given below *except* those relating to carbon resistors, carbon composition and wire-wound resistors and fixed mica condensers have been developed under the direction of the author at Calcutta and Bangalore.

(1) *Carbon resistors* (developed at the *Department of Applied Physics, Calcutta University*, during 1941-42 under *Bengal Government Industrial Research Scheme*).—Graphite after being mechanically powdered is sieved through silk lawns, and the particle size tested under a microscope. Air flotation process has been adopted for sizes 2 to 20 μ . Special colloidising mills have been employed for incorporation with water. The suspension thus obtained can be graded by knowing the amount of graphite in a given volume of mixture. Glass rods 2-3 mm. dia. are

coated with the mixture and heat-treated in a furnace upto 150° C. The coated rods are tested in a special fixture of mercury electrodes. Finally, encasing is made in a lead-tin alloy in the casting fixture. The outer cover of the rods is of glass. It has been possible to obtain resistance rods from 100 ohms to several megohms by suitably standardising the mixture before coating.

(2) *Carbon composition resistors* (as developed at the *E. T. Department, Indian Institute of Science, Bangalore*,* during 1942-43 under *B.S.I.R. Scheme*).—Composition type of resistances incorporate carbon in the form of an electrical base, an inert material as a filler and a resin bond. The inert material may be sand, talc, asbestos pulp or some other similar substance. The filler with the appropriate quantity of powdered carbon is bonded with a resin (natural or synthetic) to give a resistor unit of the desired value. The size of the resistor is determined by its rating (i.e., the wattage it has to dissipate).

The process of manufacture starts with the preparation of the mixture consisting of finely powdered carbon, the binder and inert materials. The ingredients are passed through a mixing machine and the mix is moulded into rods of the required diameter.

In the process of hot-moulding, the material is not only shaped in the mould but also hardened to such an extent that further heat-treatment becomes unnecessary. As the hardening takes place inside the mould, the machine has to be in use for a longer period than in cold-moulding but this slight disadvantage is more than compensated by the many advantages of hot moulding. Many rapid-action resins which harden extremely quickly have been in the market in recent years. The article is hard when it leaves the mould, so that scarcely any deformation takes place. Moreover, the moulded part when removed from the die possesses a highly glazed surface which makes further treatment unnecessary.

It is very important to decide the temperature at which the mix has to be moulded. The period and pressure of moulding are equally important.

The moulded resistors are cut to the proper size and their ends are coated with a thin film of copper or a suitable solder. This can be done by a metal spray gun. The terminals may be either in the form of caps or in the form of leads.

(3) *Wire-wound vitreous enamelled resistors* (as developed at the *Indian Institute of Science, Bangalore** during 1942-43 under *B.S.I.R. Scheme*).—Wire wound vitreous enamelled resistances are made by winding a special resistance wire (nichrome) of low temperature coefficient upon a refractory base. The base, including the terminal connections, is coated with a powdered glassy enamel and fired at red heat. The vitreous enamel embeds and protects the wire and is chemically inert with respect to the resistance element even at high temperatures. The vitreous enamel is an easily fusible silicate, consisting of colourless glass rendered opaque by the addition of some colouring metallic oxides such as is used in glass manufacture.

The materials used in the preparation of the enamels are flint, felspar, borax, cryolite, fluorspar, sodium nitrate, nitre, antimony compounds, oxides of tin, lead, zinc, magnesium and zirconium. For colouring, the oxides used are cobalt, iron, manganese, chromium, nickel and uranium. The selection of raw materials and their proportions depend upon the material to be enamelled and the fusion temperature desired. The raw materials are finely ground, mixed together and melted in a furnace. The liquid melt is poured into water, where it freezes to a glass and at the same time breaks up into small particles. They are ground to a fine powder, mixed with water, and either clay or suitable organic materials are added to keep it in suspension.

(4) *Variable air condensers*.—The equipment required include, dies and punches for cutting the plates according to the diagram, a press for operating the dies, and special spacing plates ground and polished so that they do not differ in any place by more than a mil. Besides these, two special jigs are required for fixing and moulding. The spindles should be well turned and the bearings drilled in a precision lathe.

(5) *Fixed mica condensers* (developed at the *Department of Applied Physics, Calcutta University*, during 1941-42 under *Bengal Government Industrial Research Scheme*).—The dielectric constant and power loss of the mica plates before they are used for the condenser are measured by the Schering Bridge. The mica is split into different thicknesses and gauged with a dial gauge so that the thickness does not differ by more than 1/2000th part of an inch. For testing the mica

* *Electrotechnics*, 1941, 14, 50.

* *Electrotechnics*, 1941, 14, 51-52.

plate for freedom from cracks and flaws, a special optical arrangement has been used and an electrical contact device shows up the incipient current when the mica is placed between the two plates under pressure. Special dies and punches are needed for cutting mica and metal foils, and assembling jigs for the condensers. A special hot press is used for application after impregnation with paraffin, and it is tested finally with a capacity bridge. Special dies and punches have been used for the manipulation of moulding powder. For the final moulding, a hydraulic press is required.

(6) *Moving coil loudspeakers* (developed at *Kanodia Electrical Communication Laboratories, University of Calcutta*, during 1941-42 under *Bengal Government Scheme*).—The primary consideration in the manufacture of a moving coil loudspeaker is the development of a cone of the best apical angle (about 110°) from paper or paper-pulp of the desired effective mass, stiffness and mechanical resistance. For the paper cones, four types of paper of specifications given below, and manufactured by *Titagarh Paper Mills Ltd.* have been examined.

- (a) 140 gms./ $(\text{metre})^2$ green paper, 7.8 mils. thick (designated 60 lbs. green),
- (b) 163 gms./ $(\text{metre})^2$ brown paper, 9 mils. thick (designated 70 lbs. brown),
- (c) 187 gms./ $(\text{metre})^2$ dark brownish paper, 9 mils. thick (designated 80 lbs. dark brown), and
- (d) 233 gms./ $(\text{metre})^2$ dark brownish paper, 14.5 mils. thick (designated 100 lbs. brown).

It has been found that with 60 lbs. greenish paper, the volume is much greater than, and the quality decidedly superior to, several English and American loudspeakers in the market for the same audio input and for the same construction of loudspeaker. At the cone manufacturing shop (called shop No. 1), cones of different dimensions and apical angles are prepared and corrugations impressed on them by means of presses specially designed for the purpose. This gives the desired types of cones with commercial rapidity. To secure the required stiffness and to remove kinks on the paper, the selected paper is first soaked in a dextrine solution and then treated with steatite powder before passing it on to the press.

The development of the various types of centering system has received careful consideration. The corrugated paper centering piece fixed to the cone with its centre floating,

and the spider type of centering piece fixed to the cone with its centre fixed, have been developed with success. For the floating centre type, an Indian paper of suitable specifications has been discovered; for the centre-fixed type, a very thin sheet of Indian mica (of sufficient mechanical strength) or *petrinax* paper cut to the proper shape by a shear press has proved a success. The best adhesive for fixing the centering systems to the cone, is casein paste. Shop No. 2 devotes itself to the development of the centering systems and fixing the same to the cones.

The design and construction of the speech coil have received considerable attention. Aluminium sheet rolled to a thickness of 3 mils. has been used as the former of the speech coil with satisfactory results. A thin coating of golden lacquer is first applied over the aluminium former before winding the coil and any apprehension of short circuiting is thereby removed. A speech coil (of 38 s.w.g. enamelled copper wire) of impedance matching with that of the transformer over the frequency range 30-10,000 c.p.s. is wound over the former by a special coil winder and a suitable adhesive like *durofix* or casein paste applied to it. The impedance-frequency characteristics are then obtained and compared with those of the transformer winding. The framework to which the cone (together with the speech coil) as well as the field system are fixed is made of a light cast metal. Aluminium has been used in most cases but sometimes thin (galvanized) iron sheets may be also used. The framework is punched and pressed out of thin sheets of this metal. In the absence of thin sheets, it can be designed from suitable hemispherical metal bowls of symmetrical forms by removing certain portions of metal from the two sides and boring them at the required positions. The framework in imported loudspeakers is usually welded to the core of the field system and thus suffers from the disadvantage that the removal of the core from the framework in case of any defect in the field system is somewhat difficult. The framework in the present case is screwed on to the core.

The field system for d.c. mains excitation types consists of the core, the former for winding the coil and the field, while for permanent magnet types, it consists of the magnet only. The core together with the yoke is made of a suitable type of soft iron which is turned into the form of a rectangular U. The field coil consists of a large number of turns (6,600 or more) of enamelled copper

wire (of 41 s.w.g.) wound over the former made up of two plane circular sides of press-pahn board joined by means of a cylindrical metal piece and fitted over the core. For the permanent magnet type, the manufacture of permanent magnets of the desired size and strength from the alloy steel available in India has been undertaken. Shops 3 and 4 are engaged in coil-winding and framework building activities. After the various parts have been developed, they are assembled into complete units at the assembly shop (shop 5).

The reproduction quality of the loudspeaker is then tested. It is known that frequency distortion has a predominant effect on quality, and that other types of distortion will not be observed until this is more or less completely eliminated. The response—frequency characteristic has therefore to be carefully measured.

Measurements of sound pressure are carried out in an acoustically dead testing room, for different directions of radiation, and the axial and mean-spherical sound pressures at various frequencies obtained over the frequency range 30-10,000 cycles/sec. The acoustically dead testing room in the Kanodia Electrical Communication Engineering Laboratories of the University College of Science at Calcutta has been carefully designed; the results of elaborate experiments on the absorption properties of Indian acoustic materials conducted by the writer have been made use of in its construction, it is perhaps the most dead of all the testing rooms elsewhere. The controls and measuring equipments are placed in an adjoining room, and only the loudspeaker under test and the microphone are placed in the acoustically dead testing room. Measurements have also been carried out in a typical living room, the loudspeaker being fed from a warble tone oscillator. The effect of

the baffle and the cabinet has also been investigated. Comparative tests in the performance of the loudspeakers produced in India with that of imported loudspeakers of similar design and construction, have shown that the former is not inferior to foreign makes in any way.

A list of materials including adhesives and chemicals required for the manufacture are given in Table II.

TABLE II.

Materials.	
1. Papers and paper pulp for cone.	10. Insulating material.
2. Press-board.	11. Screws.
3. Press-pahn paper.	
4. Mica.	<i>Adhesives, varnishes and chemicals.</i>
5. Aluminium sheet (3 mils. thick)	1. Cameron glue.
6. Enamelled copper wires of various gauges for speech coil, field winding and output transformer winding.	2. Casein glue.
7. Aluminium framework.	3. Dextrine paste.
8. Soft iron or mild steel core material for field system.	4. Dextrine solution.
9. Stalloy stampings (T and U) for	5. Casein paste.
	6. Durofix.
	7. Golden Laquer.
	8. Steatite slab.

(7) *Power Transformers for Radio* (developed at Kanodia Electrical Communication Engineering Laboratories, University of Calcutta, during 1939-41).—Single phase power transformers of small output are required for supplying power to radio receivers, amplifiers, oscillators, etc. For these purposes, the output range of the transformers lies between 20 V.A.—400 V.A. The design and construction of such small power transformers may be carried out by various methods. The turns per volt method is simple, straightforward and quite satisfactory. After determining the gauge of the wires and the number of turns in the primary and secondary windings, the mean winding lengths, the core size and losses, etc., from the given specifications of the transformer, the construction may be carried out as follows:—

Core.—The core is assembled from rectangular straight sheets of silicon steel, 18 mils. thick. The iron strips are cut to the

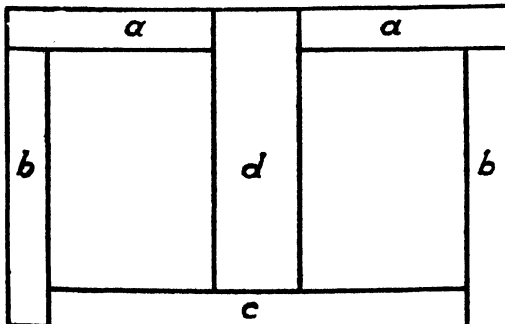


Fig. 6.

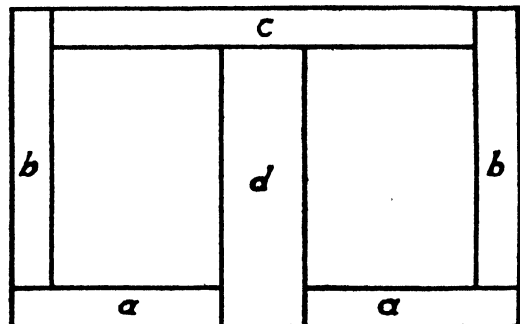


Fig. 7.

required size and assembled to form a shell type core in the manner shown in the diagrams (Figs. 6 and 7). Two consecutive stampings in the arrangement are shown. In all stampings, strips of four different sizes (*a*, *b*, *c* and *d*) are used. The width of *d* is double that of the other strips. It will be noted that the arrangement of strips in stampings is reversed in successive layers. The joints of strips in one layer are thus covered by the magnetic material in the adjacent layer. This arrangement leads to the reduction of the magnetizing component of the primary current as also the reluctance of the iron circuit to a minimum. Particular care is taken to see that the air gaps at the joints of the two strips are eliminated. After assembly, the core is kept in position by two pairs of iron clamps held by pairs of long screws and nuts. One side of the iron strips is generally insulated by an appropriate insulating material such as *Insulin* in order to reduce the eddy current loss. The usual procedure is to spray the insulating material on the plates with an air brush and then to dry it by passing each plate over a series of gas jets. The thickness of the insulating layer is about 1 mil.

Windings.—The coil bobbins are made of fibre which after being shaped to the required dimensions easily retain their shape when the coils are wound over them. For our purpose, the bobbins are made of press-pahn papers about 1/16" thick; the flanges are also made of the same material.

The proper arrangement of the coils is a matter of great importance, as it is desired to have as small a voltage drop as possible under load conditions. The coil terminals are taken through small holes drilled through the flanges and fitted with insulating sleeveings.

Insulations.—Insulation between different windings as also between adjacent layers of the same winding are applied according to a standard practice. The following table (according to Blakey) gives the recommended maximum R.M.S. volts per winding layer. The paper insulation is applied after each layer is completed.

TABLE III.

Paper thickness in inches.	Maximum size of wire in S.W.G.	R.M.S. volts per layer.	
		Double paper.	Single paper.
Kraft paper	0.002	26	150
	0.003	17	200
	0.005	17	350
Tissue paper	0.0005	40	50
	0.0010	38	75
	0.0015	31	140
			70

As regards inter-winding insulation, the following approximate values of insulation thickness are found to be satisfactory.

TABLE IV.

Voltage in volts	Thickness of insulation in mils.
110	40
400	45
1000	65

The insulating material used between two windings is one of the following:—Leatheroit paper, empire cloth, press-pahn paper.

Subsequent treatment.—The completed transformer is then properly clamped and put into a vacuum chamber for a considerable time so that traces of moisture may be driven off as far as possible. The body of the transformer and the coil are varnished and then subjected to the different electrical tests. When the test report is satisfactory, the transformer terminals are soldered to binding screws, and fitted to a small ebonite board bearing the different terminal markings.

(8) **Vibrators**—(developed at the Department of Electrical Technology, Indian Institute of Science*, Bangalore, during 1944-45 under the Institute Industrial and Applied Research Scheme).—The non-synchronous type of vibrator, developed at the Indian Institute of Science, consists mainly of (1) the vibrating system and accessories, (2) the transformer and (3) the rectifier unit. The vibrating reed is made of a thin strip of tempered steel spring of thickness 24 mils., width ¼" and total length 2½". One end of the reed is rigidly clamped to a soft iron frame forming the pole-piece of an electro-magnet while the other (free) end carries a soft iron armature of dimensions 1" x ½" x 1/16" to increase the amplitude of the reed necessary for contact pressure. The electro-magnet has been fitted on one side of the armature with a clearance of 5/32" from it when the reed is at rest.

While vibrating, the reed alternately makes and breaks the contacts with fixed brass plates of 1/32" thickness mounted 1½" high from the clamp base on either side. The make and break contacts of the reed are mounted on copper strips, 1/32" thickness, which are riveted to the reed at ¼" above the base. The frequency of the reed is about 100 c.p.s.

For contacts, pure silver is suitable when the breaking current does not exceed one

* Electrotechnics, 1945.

amp. For higher breaking currents, a gold-silver contact is more suitable. The contacts are of the "ground disc" type, the diameter depending upon the maximum current in the circuit to be broken.

The following results have been obtained from investigations on the design of non-synchronous vibrator:—(1) The soft iron armature attached to the free end of the reed increases the amplitude of vibration but lowers the frequency; (2) the ratio of make to break time (with contacts) should be 3 to 1 to obtain the desired waveshape of

A.C. generated in the transformer secondary; (3) the separation between the contacts depends upon the current in the circuit to be broken and the ratio of make to break time; (4) the use of the normal spark quench circuits gives rise to high voltage surges of short duration on the transformer secondary and therefore, spark quenching has been effected by keeping the reed frequency high and increasing the spark gap and (5) a condenser of 0.6 to 0.85 micro-farads across the secondary winding by-passes the surge voltage and improves the voltage wave-form.

Products Manufactured

The basic parts and components which have been or can be manufactured in India are given below:—

<i>Part and/or component.</i>	<i>Manufacturing concern.</i>
I. <i>Copper wires.</i>	
Single wires D.C.C., D.S.C.	<i>National Cable Works, Calcutta.</i> <i>Indian Cable Co., Calcutta (gauges lower than s.w.g. 41).</i> <i>U.M.S. Radio Factory, Coimbatore (upto s.w.g. 38).</i> <i>Government Electric Factory, Bangalore (upto s.w.g. 30).</i> <i>U.M.S. Radio Factory, Coimbatore; Government Electric Factory, Bangalore.</i>
Stranded wires	
Insulated cables	
Enamelled wires	
II. <i>Resistances (Resistors).</i>	
Wire wound (fixed type)	<i>Radio Supply Stores Ltd., Calcutta; National Radio and Engineering Co., Ltd., Bombay; U.M.S. Radio Factory, Coimbatore.</i>
Wire wound (variable type)	<i>Radio Supply Stores Ltd., Calcutta; National Radio and Engineering Co., Ltd., Bombay.</i>
Wire-wound (vitreous enamelled type).	<i>Indian Institute of Science, Bangalore; Hindustan Construction Co., Ltd. (Radio Section), Bombay.</i>
Carbon	<i>Department of Applied Physics, University of Calcutta.</i>
Carbon composition	<i>Indian Institute of Science, Bangalore; Hindustan Construction Co., Ltd. (Radio section), Bombay; U.M.S. Radio Factory, Coimbatore; National Radio and Engineering Co., Ltd., Bombay.</i>
Deposited film	<i>Radio Supply Stores Ltd., Calcutta; Hindustan Construction Co. (Radio section), Bombay, (these are being developed).</i>
III. <i>Volume controls.</i>	
Wire-wound	<i>Radio Supply Stores Ltd., Calcutta; National Radio and Engineering Co., Ltd., Bombay.</i>
Deposited film	<i>National Radio and Engineering Co., Ltd., Bombay; Radio Supply Stores Ltd., Calcutta; Hindustan Construction Co., Ltd. (Radio section), Bombay, (this is being developed).</i>
IV. <i>Fixed condensers.</i>	
Tubular paper	<i>Radio Supply Stores Ltd., Calcutta; U.M.S. Radio Factory, Coimbatore; Hindustan Musical Products Ltd., Calcutta; National Radio and Engineering Co., Ltd., Bombay.</i>
Mica	<i>National Radio and Engineering Co., Ltd., Bombay; U.M.S. Radio Factory, Coimbatore; Indian Institute of Science, Bangalore; Department of Applied Physics University of Calcutta; Globe Radio and Engineering Co., New Delhi. (?)</i>

<i>Part and/or component.</i>	<i>Manufacturing concern.</i>
Electrolytic	<i>National Radio and Engineering Co., Ltd., Bombay; U.M.S. Radio Factory, Coimbatore; Hindustan Construction Co. (Radio section), Bombay. (These concerns can manufacture only on receipt of aluminium foils of 99.95 per cent. purity.)</i>
V. <i>Variable condensers.</i>	
Tuning	<i>National Radio and Engineering Co., Ltd., Bombay. (Manufacture 2 or 3 gauged condenser of maximum capacitance. .0005 μ); U.M.S. Radio Factory, Coimbatore; Globe Radio and Engineering Co., New Delhi. (?)</i>
Trimmers and padders	<i>National Radio and Engineering Co., Ltd., Bombay; Radio Supply Stores, Ltd., Calcutta; U.M.S. Radio Factory, Coimbatore; Hindustan Musical Products Ltd., Calcutta.</i>
VI. <i>Iron cored chokes</i> ..	<i>Radio Supply Stores, Ltd., Calcutta; Hindustan Musical Products Ltd., Calcutta; U.M.S. Radio Factory, Coimbatore; National Radio and Engineering Co., Ltd., Bombay; Government Electric Factory, Bangalore; Department of Applied Physics (Elec. Communications section), Calcutta University; Indian Institute of Science, Bangalore (E. T. Department); Globe Radio and Engineering Co., New Delhi. (?)</i>
VII. <i>L. F. and power transformers.</i>	Do.
VIII. <i>H. F. Chokes, Air-core Tuning Coils and I. F. Transformers.</i>	<i>National Radio and Engineering Co., Ltd., Bombay; U.M.S. Radio Factory, Coimbatore; Radio Supply Stores Ltd., Calcutta.</i>
IX. <i>H. F. Iron Dust Core Coils and I. F. Transformers.</i>	<i>National Radio and Engineering Co., Ltd., Bombay.</i>
X. <i>Switches.</i>	
Toggle	<i>National Radio and Engineering Co., Ltd., Bombay.</i>
Rotary	<i>U.M.S. Radio Factory, Coimbatore; National Radio and Engineering Co., Ltd., Bombay; Hindustan Musical Products Ltd., Calcutta.</i>
XI. <i>Loudspeakers (Moving coil).</i>	
Energised	<i>Department of Physics (wireless laboratory), Calcutta University; Department of Applied Physics (Kanodia Electrical Communication Engineering Laboratories), Calcutta University.</i>
Permanent magnet	<i>Department of Applied Physics (Kanodia Electrical Communication Engineering Laboratories), Calcutta University.</i>
XII. <i>Vibrators.</i>	
Non-Synchronous ..	<i>Rama Radio Manufacturing Co., Delhi; Indian Institute of Science (Department of E.T.), Bangalore.</i>
Synchronous ..	<i>Indian Institute of Science (Department of Electrical Technology), Bangalore (under development).</i>
XIII. <i>Accumulators</i> ..	<i>Bharat Battery Manufacturing Co., Calcutta; Oriental Mercantile Co., Ltd., Calcutta; Amco Ltd., Bangalore and Bombay; National Battery Manufacturing Co., Ltd., Calcutta; Estrella Batteries Ltd., Bombay.</i>
XIV. <i>Dry batteries</i>	<i>National Carbon Co., Ltd., Calcutta.</i>
XV. <i>Rubber parts.</i>	
Rubber plugs-Grommets-Washers.	<i>Kohinoor Rubber Works, Calcutta; Bharat Rubber Works, Calcutta; Sind Auto Engineering Co., Karachi.</i>
XVI. <i>H. F. Insulators</i>	<i>Government Porcelain Factory, Bangalore.</i>
XVII. <i>Valve Holders, Knobs, Dials, insulating sleeves, Banana plugs.</i>	<i>Government Electric Factory, Bangalore; National Radio and Engineering Co., Ltd., Bombay; U.M.S. Radio Factory, Coimbatore; Hindustan Musical Products Ltd., Calcutta; Radio Supply Stores Ltd., Calcutta.</i>

Part and/or component.

XVIII. *Coil shields, Machine screws, Tags, Terminals, etc.*

Manufacturing concern.

National Radio and Engineering Co., Ltd., Bombay; Radio Supply Stores Ltd., Calcutta; U.M.S. Radio Factory, Coimbatore; Hindustan Musical Products, Ltd., Calcutta; Government Electric Factory, Bangalore; Aluminium Manufacturing Co., Ltd., Dum Dum.

XIX. *Cabinets*

Do.

Markets

At the present moment, about 50,000 radio receiving sets are required every year for the new broadcast listeners, and large quantities of radio parts and components are needed for maintaining and servicing of about 200,000 radio broadcast receivers and a good number of communication receivers and transmitters existing in the country, and for the assembly of about 100,000 amplifiers per year. This gives one an idea of the number and variety of parts and components which require to be manufactured every year, and also of the number of radio receiving sets and amplifiers which should be assembled per year. It has been stated in the preceding section that all parts and components except valves and electrolytic condensers have been produced in India, but the quantities actually produced are inadequate for our needs and have been used only for the assembly of a few thousand radio sets with imported tubes and electrolytic condensers, and for servicing a small portion of the existing sets in the country.

The number of radio receiving sets in India in 1944 worked out to about 0.5 per 1,000 persons. If it is proposed to increase the number to 2 per 1,000 persons (as suggested by the Communications Sub-committee of National Planning Committee in 1939-40), then this figure will be reached in about 12 years with the present rate of increase of 50,000 sets per year. With the prospects of wider expansion of the radio broadcasting service in India and the substantial reduction in the price of radio sets manufactured in the country, the requirement of the radio receivers per year may be double the number indicated above, i.e., about 100,000. The figure of 2 sets per 1,000 persons may then be reached in 5 to 6 years' time. Based on the production cost of the various parts and components already manufactured in India, a rough estimate of the manufacturing cost of a 5-tube, 4 bands, A.C. super-heterodyne radio receiver in India can be obtained. The specifications of the set are as follows:—

- (1) Valves-5-6SA7, 6SK7, 6SQ7, 6U6GT and 80;

- (2) wave ranges—four-545-200 metres, 94-35 metres, 40-24 metres, 25-13 metres, and

- (3) Audio power output—2.7 watts undistorted and 4.0 watts maximum.

The total manufacturing cost of the parts and components for the above together with the assembly cost of the set will vary from Rs. 49 to Rs. 61 provided every item is manufactured in India. If all parts and components (except valves) are manufactured in India and the five valves are imported from the U.S.A., the cost will vary from Rs. 59 to Rs. 70.

It looks as though with the establishment of factories for the manufacture of valves and other parts and components, and also for the assembly of sets on a well organized basis, it will be possible to buy a 5-tube, 4 bands super-heterodyne set which will pick up all the Indian stations and most of the foreign ones, within Rs. 70 to start with. With this substantial reduction in the selling price to one-third of the pre-war selling price for imported sets, the number of sets demanded per year by the public will be far larger than the present figure of 50,000. Further, with the wider expansion of the commercial radio services other than broadcasting in India in the post-war period, the parts and components required for replacements in radio transmitters and other equipments will be very substantial. It must be noted here that adequate protection from the Government of India against imported sets and components will be necessary for the establishment of the radio industry in India.

In addition to the home consumption, the neighbouring countries—Burma, Malay States, Ceylon, China, Afghanistan and Persia,—all of which have their own broadcasting stations, and also receive transmissions from India, may buy annually a total of about 50,000 sets and a large number of parts and components for their maintenance and service.

The question of marketing radio sets and components abroad in the post-war period is not without interest. The following lines taken from *Radio Markets after the War*

recently published by the *Institute of Radio Engineers*, New York, may show the trends in the world's largest radio manufacturing country:—

"In such a study attention must be directed not only to past export experience and the potentials of the future, but also to the possibilities of competition from abroad. Much of this will be intimately tied up with the expansion of radio industries in countries that have been producers in the past as well as with the establishment of radio factories in countries which formerly imported all their requirements."

Future Developments

It will be seen that the radio industry has hardly made a beginning in India and the production of basic radio parts and components is but a small percentage of the country's minimum requirements.

The development of the radio industry in India is intimately associated with the expansion of the radio communications and radio broadcasting, specially of the latter, in this country. Funds allocated for radio broadcasting developments have been limited with the result that there has been provision only for the short-wave second grade service. There has been some expansion of the first grade service by medium wave stations, but the progress has been slow. In order that the broadcasting service in India may be fully effective, the Government of India must have the following threefold objectives:

- (1) The whole area of the country (at least the populous portions of it) should be brought under adequate and reliable first-grade coverage;
- (2) there should be adequate distribution of private and community radio receivers in order that the programmes and messages might be conveyed to the largest number of people; and
- (3) provision should be made for effective organizations, central and regional, whose duty would be to formulate policies regarding programmes.

To realize objectives (1) and (2) with which we are concerned here, it will be necessary to make provision for research and manufacture of apparatus, on a generous scale.

A ten-year plan for the developments suggested under (1) and (2) is as follows:—
(a) For the first grade service, the present world average of antenna power (in watts) per square kilometre of area is approximately 0.1. This includes developed countries of

Europe and America where first grade coverage works out to be from 2 to 3 watts/square kilometre. The objective in India should be to install (i) sufficient number of medium-wave transmitters for regional programmes so that the first grade coverage may be increased from 0.009 (the present value) to at least 0.1 and (ii) short-wave transmitters for broadcasting national programmes. (b) The expansion of first-grade service will not be of much ultimate use in the absence of a wide distribution of radio receivers in the country. The number of radio receivers at present (in 1944) is about 0.5 per 1,000 persons. This number should be increased to at least 2 per 1,000 persons in the next 10 years.

The distribution of radio broadcast receivers may be classified under two heads—
(a) Private radio receivers, and (b) Community radio receivers. Remembering that the earnings of an average middle class educated Indian is between Rs. 75-100 per month, the price of the battery or mains operated medium wave set capable of reproducing faithfully and satisfactorily, with an input voltage of 30 to 40 mv., at least one programme for this class of persons, who form the bulk of listeners, should not exceed Rs. 30. Similarly, a battery or mains operated short and medium wave set, capable of giving most of the Indian short and medium wave stations, if made available at a price not exceeding Rs. 70, will help growth of listeners. It is, therefore, of the utmost importance that the price of the radio receivers should be reduced. This brings us to the question of manufacturing radio parts and components, including valves, and of assembling complete receivers more cheaply in this country.

The valve is the only item which has not received any attention so far in India. At least two factories (one in the North and another in the South) should be immediately established in this country for the manufacture of valves and necessary machinery be imported from U.S.A. or U.K. The principal items of equipment required are (1) Grid-winding machine, (2) Filament-coating plant, (3) Pumping unit and battery of pumps, (4) Sealing equipment and (5) Glass blowing equipment. The investigations which might be taken up in connection with the valve industry are (1) Preliminary studies on the material, dimensions, constructional and mounting details relating to various electrodes, and on the material, dimensions, mount-

ing, etc., of the connecting leads, in different tubes. (These studies will provide sufficient practical design data which will be of immediate industrial value); (2) Studies on glass and vacuum and metal-glass sealing requirements for hard thermionic vacuum tubes; (3) studies on the gas properties of electrode materials (including re-absorption of gas); and (4) studies on the possibility of reconditioning damaged tubes.

The materials required for the manufacture of tubes are chiefly (1) nickel, (2) molybdenum and its alloys, (3) nickel-manganese alloys, (4) iron, (5) tungsten, thoriated tungsten, caesium-on-oxygen-on-tungsten, (6) alkaline earth oxides, (7) alumina, (8) molybdenum-tungsten alloy, (9) beryllia, (10) magnesia, (11) alkaline earths, alkali metals and magnesium getters, (12) alloy of barium and magnesium, (13) suitable glass tubes for making envelopes, (14) suitable material for socket and adhesive for securing glass bulb to the socket, (15) glass insulators, and (16) mica.

In addition to the valve manufacturing factories, three concerns in Northern India and three in Southern India, selected from amongst the concerns which are now producing other parts and components, should be

fully equipped for the manufacture of the parts and components other than valves. One of the three concerns in the northern group should devote itself entirely to the manufacture of variable and fixed condensers, resistors of all types, valve bases and other accessories; the second concern should concentrate on transformers of all types and loudspeakers; and the third concern should take up the manufacture of wires, cables, special wires, etc. Similarly for the three concerns in the southern group. The assembly may be done at two other factories or establishments, one in the north and another in the south which may be Government-owned or Government controlled. Such establishments should evolve suitable designs, control, standardize and test the products, secure all raw materials to the four factories, assemble the parts and components into complete sets or equipments, and finally distribute them to the trade and Government Departments. There will thus be 8 factories in India devoted to the manufacture of radio parts and components and 2 factories devoted to assembly and control. The scale of operation of the factories should be such as to produce a total of 100,000 cheap radio sets of super-heterodyne and straight types per year.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, LONDON

ORIGIN AND FUNCTIONS

THE Department of Scientific and Industrial Research is the outcome of a scheme issued by the President of the Board of Education in July 1915, which contemplated the establishment of

- (a) a Committee of the Privy Council responsible for the expenditure of any new moneys provided by Parliament for scientific and industrial research;
- (b) a small Advisory Council responsible to the Committee of Council and composed mainly of eminent scientific men actually engaged in industries dependent upon scientific research.

These bodies were brought into existence by an order in Council dated 28th July 1915.

The scope of the work of the Department embraces all branches of natural science and all industries except agriculture, medicine,

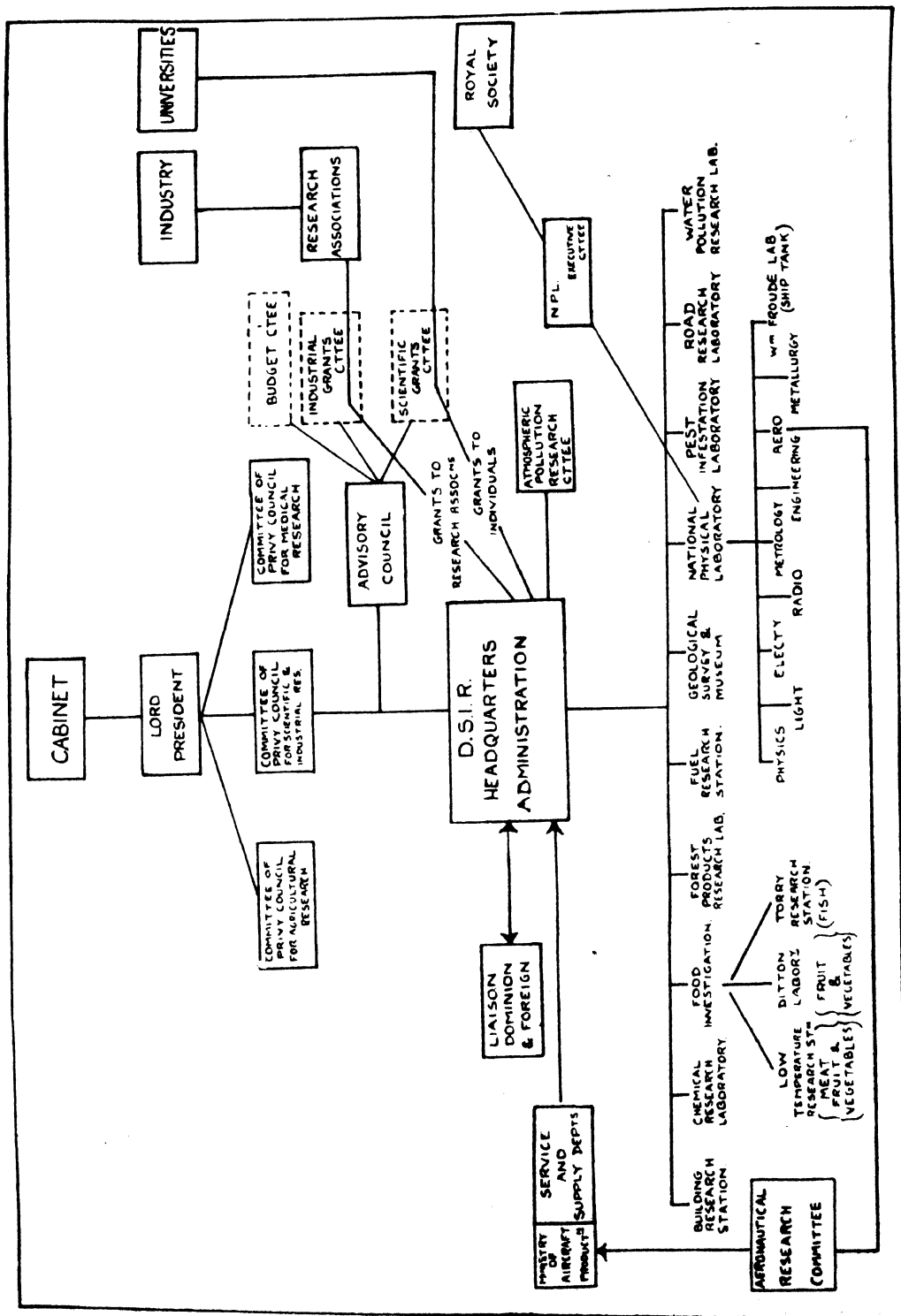
fisheries and forestry. The main activities fall into the following groups:—

- (a) Grants for investigation and research.
- (b) Encouragement of research in industry.
- (c) Conduct of tests and special investigations for outside bodies and firms.
- (d) Research required for Government purposes, or undertaken in the national interest for the general benefit of the community.

Organization

The organization consists of a Headquarters office in London and the following research stations and laboratories, in which the bulk of the work undertaken by the Department is conducted:—

- (a) The National Physical Laboratory, Teddington;



Organization of the Department of Scientific and Industrial Research.

- (b) The Building Research Station, Garston near Watford;
- (c) The Chemical Research Laboratory, Teddington;
- (d) Food investigation Stations: Low Temperature Research Station, Cambridge; Torry Research Station, Aberdeen; Ditton Laboratory, East Malling, Kent.
- (e) The Forest Products Research laboratory, Princess Risborough;
- (f) The Fuel Research Station, East Greenwich, with local laboratories for the physical and chemical survey of the national coal resources at Birmingham, Cardiff, Chester, Glasgow, Leeds, Newcastle-on-Tyne, Nottingham and Sheffield;
- (g) The Road Research Laboratory, Harmondsworth, Middlesex;
- (h) The Water Pollution Research Laboratory, Watford; Minworth Laboratory, Birmingham.
- (i) The Pest Infestation Laboratory, Slough, and
- (j) The Geological Survey of Great Britain (and the Museum of Practical Geology), South Kensington, with branch survey offices at Edinburgh, Newcastle and Manchester.

In addition, a certain amount of scientific work, though relatively small, is undertaken for the Department by university and other laboratories.

All information already existing and in the possession of the Department is made freely available to *bona fide* inquirers. Problems requiring experimental work, brought to the Department for solution by private parties are investigated on suitable payment. Facilities also exist for the study of problems entailing extended investigation in a field not directly covered by a Research Association. In this case the facilities available in the laboratories of the Department are placed at the disposal of the industry which is prepared to co-operate technically and financially.

The distinctive feature of the Department's activities is the extent to which the work is planned. An appropriate balance is maintained between its various parts on the advice of non-official experts and men of science. The Research Boards and Standing Committees command the unpaid services of distinguished bodies of men capable of bringing to their task a critical knowledge of current technical and scientific practice.

Fig. 1 gives in outline a general picture of the organization of the Department.

Executive power is vested in the Committee of Privy Council for Scientific and Industrial Research, of which the Lord President is Chairman. In practice, the Lord President exercises the powers of the Committee of Privy Council.

The Lord President is advised by an Advisory Council to which eminent scientists and industrialists (one of whom is chairman) are appointed in approximately equal numbers upto a total of about a dozen. The Secretary of the Department is also the Secretary of the Advisory Council.

To the Advisory Council are referred for report and recommendation proposals for

- (a) instituting specific researches;
- (b) establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; and
- (c) establishment and award of Research Studentships and Fellowships.

The Council may itself initiate such proposals and may advise the Committee on such matters, whether general or particular, relating to the advancement of trade and industry by means of scientific research.

The Advisory Council has appointed three standing sub-committees from its own membership to give first consideration to defined topics. They are:—

- (a) The *Industrial Grants Committee* which considers detailed proposals for grant-in-aid to Co-operative Research Associations;
- (b) The *Scientific Grants Committee* which considers applications for grant to (i) post-graduate students, (ii) senior workers for specified investigations; and (iii) professors or other independent investigators of similar status for the employment of assistants to carry out specified investigations of particular interest; and
- (c) The *Budget Committee* which maintains a general supervision over the expenditure of the Department.

For administrative convenience, official liaison with Dominion and other Government organizations is maintained through the Headquarters of the Department, but individual Directors and their staffs are encouraged to establish and maintain direct contact with other scientific workers all over the world.

SCIENTIFIC CO-OPERATION WITHIN THE BRITISH COMMONWEALTH *

By A. V. HILL

IN October 1941 a Committee was set up by the Royal Society to consider means of promoting collaboration between the several parts of the Empire, first in scientific research and second in the application of science to medicine, agriculture, industry, natural resources and other matters of common concern. Since 1940, for purposes directly connected with the war, scientific representatives of the four Dominions had been present in London; and these, together with a member of the staff of the High Commissioner for India, took part in the work of this Committee with officers of the Royal Society and others. Its report, published in March 1943, referred to the general objectives of its discussions, viz., "To secure scientific co-operation in settling the emergency problems of the immediate post-war period and to ensure that the most should be made of our common scientific resources after the war for improving both scientific knowledge itself and the life of the peoples of the Empire." The report contains a number of recommendations. I will put them quite shortly:

- (1) the development of abstracting and information services as a co-operative effort between English-speaking countries;
- (2) the maintenance in London of the permanent scientific representation of the Dominions and India; possibly also in other centres overseas;
- (3) the establishment in London of a British Commonwealth Scientific Collaboration Committee to act with the Royal Society in matters of common interest and to further research and its applications throughout the Empire;
- (4) the co-operation of this Committee, when appropriate, with scientific representatives of the United States, and other countries, present in London; and
- (5) the facilitation, particularly by air travel, of personal contacts and exchanges between scientists in the countries.

There was nothing exclusive in the purpose of getting British science throughout the Empire working together; for science is the most international and universal of all subjects, having a common motive of understanding nature, a common court of appeal for observation and experiment and a common object of applying scientific method and discovery to human welfare. But instead of embarking prematurely on a grandiose scheme for the organization of world science, which would almost certainly get shipwrecked on elementary difficulties, it was thought wiser for the family to get together and make its own plans, on which, as they developed with trial and experience, the wider collaboration could more gradually be built up. If within the Commonwealth we agreed on common purposes and methods, while recognizing each of us, and that is most important, all the time, the pride and individuality of the others, we should be more likely to gain agreement and co-operation with the rest of the world. And if, unfortunately, at any future time emergency should again require our pooled resources, we should be quicker off the mark than we were this time; we should be stronger and more desirable friends and more formidable enemies.

The recommendations of the Committee were forwarded to His Majesty's Government in London and to the Governments of the Dominions and India, and general agreement in principle was found. One indirect result, due partly to our discussions with members of the Viceroy's Council then in London, was my own visit to India last winter and that of the Indian scientists here recently. A visit of Sir Henry Tizard to Australia and Canada in 1943, and many subsequent discussions with individuals and members of the Government, led directly to the decision that as soon as practicable after the war, possibly next summer but more likely in 1946, the Royal Society should call an Empire Scientific Conference in London. The idea is that about sixty delegates of the Dominions, India and the Colonies should attend, who would be

* Reprinted from the *United Empire*, 1945, 36, 56, through the kind courtesy of the Editor.

guests of His Majesty's Government during their visit, together with about forty delegates from the United Kingdom. Preliminary arrangements for this are now being planned. The Conference will probably be held in separate sections, the first to be more purely scientific, the second more purely official for working out concrete plans for submission to the Governments concerned. In an interval between the two, the visitors will travel round in small groups together, we hope, as they wish, to see what British science, industry, agriculture and medicine have to show them: and—most important of all—to gain, by informal discussion with each other, a familiar contact with each other's problems, programmes and ideas.

It is surely no commonplace to insist, and I am sure in this audience none could deny, that the British Empire and Commonwealth really does work; not because of ingenious political machinery or constitutional perfection, but because—like any living organism—it has grown up working. We learn to co-operate by co-operating, as we learn to run by running. It is easier to co-operate in scientific matters than in most things, and my visit to India would have convinced me, if I needed convincing, that the best hope of friendly collaboration between Britain and India lies in the scientific, technical and medical fields. In those fields we can deal directly with real facts, facts that affect the lives and welfare of hundreds of millions of people; not with political conjuring, not with argument by epithet, not with slogans or phrases—to quote an admirable letter in *The Times* recently—which are really an emotional by-pass for thought, but with real things. And what is true of India is even more obviously true of other parts of the British Commonwealth: the organic unity is already there if only we can give it something healthy to operate on affecting the happiness and welfare of its peoples.

Experiments and Experiences

Imperial scientific collaboration is nothing new: only it is needed on a much greater and more imaginative scale. The Imperial Institute was founded in 1887 and has many activities, particularly in relation to raw materials and natural products of the Empire. In spite, however, of its enormous field of interests, its annual budget is only £50,000, which works out at about a penny

per square mile of the Empire in which it is interested. The outstanding example of a central scientific organization working for the whole of the Empire is that of the Imperial Agricultural Bureaux. This organization, which was founded sixteen years ago, has been extremely successful in providing a vital service, collecting, collating and disseminating information on agricultural research to workers throughout the Empire. It is administered by a constitutional and representative Executive Council meeting in London; it has been continuously supported since 1929 by all the countries of the Empire on an agreed contribution basis. Then came the very close collaboration, which has existed since 1940, in all scientific matters connected with the war. The success of these experiments, and of course of many others, in scientific collaboration, in peace and in war, indicates that a wide extension is not only desirable but easily possible, if we try.

At the end of 1940, a British Central Scientific Office was established in Washington to facilitate exchange of scientific and technical workers and information with the United States. Early in 1941, a branch of the United States Office for Scientific Research and Development was set up in London for a reciprocal purpose. The British Office in Washington has always been in very close touch with the National Research Council of Canada, and lately has had working with it a number of representatives of all the Dominions. Indeed, with the approval of their Governments, it has been renamed the British Commonwealth Scientific Office and has become a general clearing house of scientific, technical and medical information between all the countries concerned in it, as well as with the United States. It has held a number of conferences in Washington and Ottawa at which more general problems of the present and future have been discussed; indeed, I believe that one such conference has just taken place at Ottawa at which the Indian scientists who were here in the autumn were present. One may hope that so good an experiment and so effective an organization may be continued, in some form appropriate to peace-time, after the war.

Since 1940 representatives of the Dominions have worked in London from the offices of their respective High Commissioners, for the same general purpose as the

British office in Washington and the United States office in London. A British scientific representative has worked, since 1940, with the National Research Council of Canada at Ottawa. In addition, of course, the service, supply and food ministries and others have sent a large number of special scientific and technical missions overseas, particularly to the United States and elsewhere. Unfortunately Indian science, which is now much more highly developed than is commonly realized, has hitherto had no outside representation anywhere: following the recent visit of the Indian scientists here it seems likely that the Government of India will set up in London an Indian Scientific Office. Possibly even an Indian Scientific Liaison Service will be established, with its headquarters in Delhi, its main overseas office in London and branches in other countries. The details of all such services and connections, and their relations to one other, will no doubt be worked out by the Governments concerned after the return of their delegates from the scientific conference that we hope to hold.

The Colonies also have important scientific interests which could be greatly furthered by closer contact with the main line of Empire development. The Colonial Research Committee and the Colonial Products Research Council, working under the provisions of the Colonial Welfare and Development Act, provide a common ground for research and its applications between the different regions and territories of the Colonial Empire. So many of the scientific, technical, agricultural and medical problems of the Colonies are analogous to those of India and parts of the Dominions that closer contact and co-operation could not fail to be of mutual advantage. To take one example only, our knowledge of tropical disease is derived very largely from research in India: but most of the diseases are to be found also in Africa and elsewhere. The Imperial Agricultural Bureau and the Imperial Institute already deal with Colonial problems on the same basis as the other problems of the Empire. The principles, or rather the practices, so effectively worked out for these could undoubtedly find much wider application in other fields.

A further promising development, affecting, may be unknown to many who are here affected, certain of the Colonies and their adjacent countries, is the attachment of two able scientific advisers to the Middle

East Supply Centre. Their reports will be awaited with very great interest. In agriculture, irrigation and soil survey; in land maintenance and land erosion; in geology, meteorology and water supplies; in forestry, plants, animals and fisheries; in health, nutrition and population; in all such directions the problems they have found, working from Cairo, are closely analogous to those existing in other parts of the Empire—but require, as usual, special methods for their solution, depending on historical, economic, social and political relations. In this region covered by the Middle East Supply Centre, science, particularly biological science, could play a part of dominant importance among the many factors which affect the welfare of the people and their relations to the outside world. To neglect these scientific factors as has been our custom usually hitherto, will lead to as certain trouble in the future as to build a house in this climate with its water pipes on the outside. That is a matter I can speak of at present with some feeling—no political conjuring can restrain water from freezing—nor can it prevent trouble when elementary biological rules affecting health, food, agriculture and reproduction are neglected.

Problems Stated

To show that scientific collaboration within the British Commonwealth is not a matter merely of vague generalities and goodwill, but of very practical detail, I should like to refer merely by headings to a few of its problems. There is no time to try to answer; I just put the problems out:

- (1) The fear of isolation which prevents first-class workers and teachers from accepting posts in more distant centres: what are its effects and how can it be overcome?
- (2) The need for quick and frequent personal contacts between research workers in analogous fields: how can air transport supply this regularly for people who are mostly poor and have no political or industrial "pull"?
- (3) The need for a combined study of natural resources and conditions, in forests, minerals, land utilization, water power, meteorology, plants, animals, pests of various kinds, disease: how can the principles of lend-lease be applied, both to the investigation

and to the application of the new knowledge so gained?

- (4) Regular interchange of personnel between the scientific staffs of universities, industrial firms and research institutes throughout the Commonwealth and Empire: what arrangements, including a common pension scheme—a very practical matter—can be made for this?
- (5) Regional research—it is obvious that certain regions are natural units for research and development in particular subjects. Such regions often fall, as in Africa, under the authority of different Governments. How to secure co-operation and sharing of effort and expense in such regions?
- (6) The direction of a concentrated attack when necessary on a key problem. Who is to decide on the problem and on the method, and on the direction from which it shall be attacked? And who is to decide how the expense is to be shared?
- (7) Training of young research workers and the higher grades of technologists and workmen, by exchange between countries which each have special opportunities to offer. How to organize and pay for such exchange?

Lastly, science and Imperial defence: secrecy as a cover for inefficiency: secrecy as a source of fear and suspicion to other people: the need for critical minds and up-to-date methods, the need for contact with recent scientific discoveries and industrial technique: the relation between civil and military research: the need of interchange between Government, university and industrial science throughout the Empire.

In all these subjects, and there are many others, imaginative planning and bold executive action are required: there will indeed be plenty of work before both sessions of the Empire Scientific Conference when it meets.

Enquiry will naturally be made about the cost of this collaboration: in fact, however, the number of good scientific workers at present available is still so small that the cost of doing all that is practically possible is almost negligible compared with that of any other first-rate enterprise. The countries of the Commonwealth and Empire must show each other by example that in times of stringency and difficulty scientific

and technical training and research are the last and not the first things on which to practise economy. India, for example, is suffering gravely now from unwise economies in 1931: it will take the Geological Survey and the Botanical and Zoological Surveys many years to recover from the cuts then made. Can we not make sure, as is happening in that wise little country Switzerland now, that more and not less effort is devoted to scientific research in times of difficulty and uncertainty, as an insurance for the future?

Lunacy of Isolationism

The days are altogether past when nations or communities could live for themselves alone. For good or ill, physical and biological science—with its applications to transport, communications, food, agriculture, industry, warfare and a dozen fields—has put isolationism as a creed, or as a practical policy, on a level with swindling or lunacy. So long as isolationism could still wear the polite disguise of practical common sense (the practical man being, as Francis Galton said, the man who practises the errors of his forefathers) so long was it possible to pretend to regulate relations between nations and communities in terms mainly of political factors. To-day, however, we must admit that politics is only one of several ways of approaching the universal problem of human society. Equally important, among others, are the methods of biological science in its widest sense, applied to the problems of general welfare; or of physical and engineering science applied to economic and industrial prosperity. No doubt the closest connection exists between all these different things, and we cannot evade the political issues. Politics, however, should be the servant, no doubt a very necessary servant, but not the master, of individual welfare and social prosperity. To allow it to continue its past dominance of the national and international scene is to perpetuate the swindle, or the lunacy, of isolationism.

Many, no doubt, brought up in the traditional view will be scornful or indignant at the impudence of a scientist who dares to challenge the sacred privilege of the politicians. They may even apply the "argument by epithet" and label it, according to taste, as Fascism, Bolshevism, or Imperialism. Well, we shall see. It is not so long ago that science successfully challenged

the dominance of law, language and ancient philosophy as the best guide to life, or the best training for public affairs. The success of politicians in regulating national and international relations has not been so very conspicuous in recent years. With the passing of isolationism the opportunity appears of scientific statesmanship: if that can take its proper place in the affairs of the British Commonwealth of Nations there is better hope that it will be able gradually to permeate the relations of the world as a whole.

Abuse and Use of Science

For the truth is that science and engineering have made the world very small indeed in time and space. In the past, a spark of trouble here or there could be isolated: to-day it may flare up into a world bonfire. And the bonfire of the future, will be no struggle between armed forces, but a deliberate attempt by scientific methods and technical weapons, to destroy cities, to massacre populations and to make whole countries uninhabitable. If traditional methods of diplomacy and politics are in future to dominate international relations, if nations nominally at peace with one another are in secret to prepare without warning to wipe each other out, then what hope can there be that some fool or some criminal will not set the process going? The decent sense of ordinary men might prevent such happenings if the facts were well known: but nations can be driven crazy by hatred and propaganda and by fear of the unknown. The only hope indeed of averting the disaster which science, misapplied, could inflict on humanity is an international brotherhood of scientific men, with some common ethical standard by which potential crimes of this character would be exposed and prevented.

For, if political isolationism and aggressive nationalism are to exploit science and its applications, not for the benefit of mankind but in order to prepare in secret for mutual destruction, they are very likely to succeed: and mankind, like the pterodactyl too successful in its flying, may become extinct. Many civilizations of the past have disappeared; but those were in the days when the speed of a man and the power of a horse determined the scale of time and space in the operation of political, social and economic forces. Like a local infection in the body, the trouble was usually

sealed off. To-day with speeds of travel nearly as fast as sound, with communication as fast as light, with sources of power potentially available beyond even the dreams of yesterday, with possibilities of injury by physical, chemical and biological methods frightful beyond any hitherto imagined, with an almost complete collapse of previous ethical standards, and the demonstration of how scores of millions of highly educated and intelligent people can be led into hate and hysteria by the methods of the scientific advertiser and propagandist—to-day it will not be a mild local infection but an acute general septicæmia. My friends, I think, on the whole, will acquit me of being given unduly to hysteria and alarm: but I am convinced, and others who know much better than I do what the possibilities are, are convinced no less, that if these terrible fears for the future are not to be realized some drastic decisions are necessary now. Political isolationism, aggressive nationalism, and secrecy in preparing methods for mutual destruction, must stop. Scientific men themselves throughout the world must be allowed to work together in mutual confidence and sincerity. Ethical standards in their work must be restored so that the misuse of scientific knowledge and discovery, the common property of mankind, either for selfish exploitation or for general destruction, will be regarded—like cowardice in a soldier or like dishonesty in a banker—as the unforgivable sin. If these conditions can be realized, there is hope for a brighter future and happier future for the world: if not, mankind driven by hatred, fear, hysteria and political catchwords, will plunge into irretrievable ruin.

It may be asked—what have these gloomy forebodings to do with the subject of this address? They have in fact a great deal. Science properly applied can offer gifts beyond price for the convenience, health, happiness and welfare of man: not only for material prosperity, but in the spiritual sphere, offering a common motive, a common method and a common object to a world torn by struggle and division—largely, indeed, about words and phrases with little of reality behind them. If any community at all can take full advantage of the offer which science holds out, that community is the British Commonwealth of Nations. We need have no fear that by doing so we are taking unfair advantage of its position, or unity; but rather the

opposite, for we still have the opportunity of leadership—the world still looks to us for leadership—and a world organization for sharing the beneficial results of scientific discovery can be built up around our prototype. If with all our initial advantages we cannot do it, what hope is there of a world organization? And if that fails what hope remains that science will not be exploited for the purpose of selfish political nationalism, will not become a cause of suspicion, jealousy and fear—instead of a tool and method of collaboration—ending next time not in war as we have known it hitherto,

but wholesale massacre and general destruction. My own conviction is that in this matter the greatest chance of leadership ever offered lies open now to the British peoples. If it is taken, the happiness and welfare of our own people can be greatly advanced; not only without injury to others but indeed with great benefit to others, and—most important of all—we shall have started on the only path which can reasonably be expected to avert the terrifying dangers which science, cultivated in secret in the service of political nationalism, is bound to bring.

I.C.I. RESEARCH FELLOWSHIPS FOR INDIA

THE Directors of Imperial Chemical Industries, Ltd., have recently announced a substantial endowment of Research Fellowships in chemistry, physics and biology, amounting to Rs. 3,36,000, to be awarded to research workers in India, through the National Institute of Sciences of India. In a letter addressed to the President of the Institute, Lord McGowan, Chairman of Imperial Chemical Industries, writes: "We thought there could be no better way of encouraging the advancement of science in India, and with it the general prosperity of the country, than by the offer of these Fellowships, which under the wide administration of your Council, will, we hope, lead to an augmentation of the distinguished success in science already attained by so many of your fellow countrymen."

The Fellowships (value, Rs. 400 per month) will be available over the next five or seven years, and will be open to persons of proved scientific ability below 35 years of age, irrespective of sex, race or religion. The Fellowships will be tenable for two years, with the possibility of extension to three years, and provision has been made for the grant of research expenses to Fellowship holders towards special apparatus and material.

It will be recalled that Imperial Chemical Industries announced in July last year, the award of eighty Fellowships in nine British universities for the promotion of teaching and research, in pursuance of the enlightened view that academic and industrial research are complementary and that real industrial progress cannot be hoped for without a corresponding advance in academic science. This view has been acclaimed by scientists

all the world over. The leaders of science from India who visited the United Kingdom last winter, paid tributes to Imperial Chemical Industries, for supporting the advancement of academic and applied research on a liberal and imaginative scale. At a luncheon which the Directors of Imperial Chemical Industries gave to the visiting scientists at Claridges, Sir S. S. Bhatnagar, in his reply to the toast proposed by Lord McGowan, referred to the provision of the Research Fellowships which Imperial Chemical Industries had just then announced, and made a strong plea for the extension of the scheme to India. Lord McGowan had assured Sir S. S. Bhatnagar that he would consider the question of endowing similar Research Fellowships in Indian universities, an assurance which he has since fulfilled.

The munificence of Imperial Chemical Industries is a stimulating example to leaders of high finance and industry in India. While the services rendered by pure and applied research to industrial advancement have been widely acclaimed, and the claims of science for financial support and encouragement by industry freely admitted, in actual practice, such assistance has been altogether too meagre and inadequate. In India where learning has been traditionally fostered by wealth, there have been a few outstanding examples of such benevolence. The expansion of the scientific resources and services on a scale large enough to meet the post-war requirements, demands the expenditure of large sums of money and the enlightened action of Imperial Chemical Industries, we trust, will encourage further unofficial benefactions for the furtherance of scientific research and development in this country.

Reports from States and Provinces

Orissa

A REPORT on the industrial survey of Orissa, carried out by Dr. H. B. Mohanty, has been recently issued. The survey covers all existing industries, and the possibilities for starting new industries have been discussed in the light of all available information on the resources of the Province. The survey provides a basis for the post-war planning of industries. The main conclusions reached by Dr. Mohanty are:

Orissa has not developed industrially as much as the other Provinces of India although she possesses considerable scope for industrial development. She is fairly well endowed with mineral, marine, agricultural, and forest resources. The development and utilization of the vast mineral, biological and plant products of the sea seem to offer great possibilities of industrial development. The provision of cheap electric power and easy transport facilities will greatly help the development of industries in the Province.

High grade iron-ore is available near Umarmot in the Koraput District, and somewhat lower grade ore in several small scattered deposits in the Sambalpur District. The Umarmot deposit is far away from coal but it may be possible to smelt the ore by using charcoal or hydro-electric power when it becomes available. It would be easier to get coking coal to Sambalpur, but the chief difficulty would be to get the scattered deposits to a central place. So both the possibilities seem to be somewhat remote. Possibility of improving and extending the cottage production of iron now in vogue in some places in the interior, may be investigated.

Secondary production of steel using pig-iron or scrap, production of ferro-manganese and establishment of a re-rolling mill for making structural steels, tools and agricultural implements seem to be possible even now.

The heavy chemical industry, specially the manufacture of salt and salt-products such as alkalies, soda ash, sodium hydroxide and bleaching powder, has great possibilities in Orissa. Fine chemicals based on coal or wood distillation products can be established in the Province. The Rampur coal is rich in volatile matter and quite suitable for distillation purposes. Pharmaceuticals such as strychnine from nux-vomica, agar-agar from Chilka weeds, and shark liver oil, can be manufactured in the Province. A sulphuric acid plant should be set up for the manufacture of alums and bichromates. Rosin oil and scents can be produced on a cottage scale. There is an immediate need for putting up a bone mill, and calcium cyanamide may be prepared when cheap electric power becomes available by using the chemical grade limestone available at Kottameta in the Koraput District.

A paper mill can be established at Cuttack, which enjoys considerable advantages. A mill at Motu would be possible even now. The possibility of having a mill at Gunupur needs further examination.

There is at present no scope for the manufacture of rayons and artificial plastics. The natural plastics

available are shellac and resin which are exported. Shellac could be made into furniture polish and insulating varnish, and the use of resin in paper manufacture needs investigation. There seems to be vast scope for making glues from waste animal matter.

The sugar mill at Rayaghada is only half-fed. Extension of the cane area at Rayaghada and the establishment of a new mill at Aska and possibly one at Gunupur seem to be urgently necessary. The cane area at Banki may be increased to allow the existing sugar mill to develop to a reasonable size. Production of industrial alcohol should be taken up on a large scale as this would help the establishment of a pharmaceutical industry and the lacquer and varnish industry in the Province.

There is one glass factory at Barang, and another factory is under construction at Mancheswar. The greater use of glass-making materials available locally, and the production of better quality glass are problems which need attention. The production of soda ash for which possibilities exist in the Province, will greatly help the glass industry. It would be desirable to investigate the possibility of manufacturing glass bangles, beads, and small bottles on a cottage industry scale as is being done in the United Provinces.

There are vast possibilities for making fireclay refractories, stoneware and porcelainware in Orissa. The best centres for the manufacture of these articles would be Jharsuguda in the Sambalpur District, and a place near Bhutanagar in the Puri District. There appears to be little scope at present for making enamelware. Tile-making ought to be introduced on a large scale. The manufacture of graphite refractories, lubricants and other products can be taken up in collaboration with the Patna and Kalahandi States by putting up a flotation plant at a central place for purifying the graphite ores obtained from these areas.

The possibility of developing a cement industry in the Sambalpur District by utilizing the huge limestone deposits at Dungi seems to be bright.

To enhance the production of soap, the first requirement is to encourage oil production. There is plenty of ochre but little linseed oil to develop the paint industry. Ganjam grows plenty of groundnuts, and there is at present a move to install a vegetable-ghee plant at Berhampur.

If hydro-electric power can be obtained cheaply the electro-metallurgical and chemical industries, such as the extraction of aluminium, production of calcium carbide and cyanamide, and of artificial abrasives like carborundum and alundum may be taken up in future.

A textile mill for Orissa is a crying need. The demand for yarn from handloom weavers alone would provide work for several spinning mills. The organization of textile workers on co-operative lines will greatly benefit the handloom industry, which is the chief cottage industry in the Province.

There is no wool industry in the Province and the silk industry is dying out for want of silk and cocoons.

The culture of eri silk seems to have good scope for development. A fairly good quantity of hemp and coir are available and they should be utilized for rope-making. Sisal could be grown at many places in the Province. There is enough market for the hosiery industry which could be introduced as a small-scale or cottage industry. Orissa grows plenty of jute, and there is ample scope for a modern jute mill.

The brass and bell-metal industry which is an important cottage industry, is in urgent need of improvement by introducing labour-saving mechanical devices. Manganese is the only non-ferrous metal available, chiefly at Kutingi in the Koraput District. The deposit is easily accessible and can be exploited for export. But it would be desirable to utilize it in the Province itself in the chemical and glass industries and in the production of ferromanganese.

There is a vast scope for the tanning and leather goods industry in Orissa as both skins and hides and tanning materials are available in plenty. Except for a few small tanning establishments, and production of leather goods by cottage workers, there is at present no factory production of leather or leather goods in the Province.

The development of the fishing industry holds great possibilities for Orissa. Introduction of deep-sea fishing, cold storage, dehydration and canning will help the speedy growth of the industry. It might be possible to have a small industry for canning and bottling of fruits and vegetables, and for preparing fruit syrups, lemon and orange squash, etc. As regards tobacco products, *bidi* making is a growing cottage industry at many places in the Province.

A plywood factory has been erected at Cuttack and is in production. There is scope for installing at Cuttack a saw mill, a seasoning kiln, a jute bobbin and helve factory and possibly a match factory.

Besides the fancy handloom products, the other cottage industries which have made Orissa famous are the filigree work of Cuttack, and the horn and ivory work of Cuttack and Parlakimedi. These cottage industries need to be organized and improved. Hat-making, cane-work and mat-weaving are useful cottage industries which could be organized on a wide scale in the Province.

Sind

Power Schemes

A two-crore rupees hydro-electric scheme to carry electric lighting to all towns in Sind has been recently initiated. As a first step in the project, the

Tandomastikhan Falls, situated across one of the largest canals of the Indus, is being shifted 15 miles upstream, involving the deepening of the canal with the dual purpose of raising the electrical potentialities of the falls and also to prevent waterlogging which has been the cause of a long-standing dispute between Sind and the Khairpur State Governments since the construction of the Sukkur Barrage.

Meanwhile, an electrical survey has been undertaken simultaneously with spade-work for the installation of hydro-electric generators capable of producing 20,000 kilowatts—enough to meet post-war lighting and other needs of Sukkur, Shikarpur, Larkana and eight other towns round about the new site of the falls. This grid system covers Upper Sind while two other systems, designed to serve Central Sind round Karachi are being worked out by the Government.

Hyderabad

Engineering Research Department

The Nizam's Government has sanctioned a scheme proposed by Nawab Zain Yar Jung Bahadur, P.W.D. Member of the Nizam's Council, for the establishment of a Department in Engineering Research, estimated to cost about Rs. 6 lakhs. Doctor S. P. Ragu, Principal, Osmania Engineering College, has been appointed as its Head and he has been asked to draw up a five-year programme in this connection. The subjects coming within the scope of this department include irrigation, soil mechanics, building materials, housing problems, road research, public health engineering, hydraulic machinery, agricultural engineering and industrial psychology. The department is to be located at Himayatsagar, ten miles from the city, and research work is expected to be started early next October.

Madras

Production of Caustic Soda

The Government of Madras have sanctioned temporarily for one year a Demonstrator and a skilled Assistant for the establishment of a peripatetic demonstration party to train villagers in the method of preparing caustic soda from alkaline earth deposits. Demonstrations will be held in selected places and the Demonstrator will assist in the survey of unexplored tracts and in carrying out any laboratory work connected with the deposits and their treatment.

Notes and News

Radium Mineral from Rajputana

AN orange yellow mineral obtained from Rajputana and showing pronounced radio activity has been examined in the University College of Science, Calcutta. Analysis of the absorption curve of the β -ray in aluminium showed that the mineral contained 60.1 ± 1.2 per cent. uranium and 0.7 ± 0.05 per cent. thorium. (Nag Chaudhri, *Ind. J. Phys.*, 1944, 18, 31). The high uranium content and high specific activity point to the Rajputana mineral as a good source of radium. It compares favourably with those minerals that are now being employed elsewhere for the extraction of radium, and yields 234 mgm. of radium per ton. The occurrence of a rich source of radium, revealed by these investigations, it is hoped, will stimulate large-scale extraction of radium in this country.

Vegetable Tanning Materials

Information relating to the known vegetable tanning materials of India, scattered in some 112 technical papers, has been brought together in one informative leaflet issued by the *Forest Research Institute* (Leaflet No. 72, 1944, *Chemistry and Minor Forest Products*). The war has created a heavy demand for leather, and Indian tanners have been seeking new sources of tanning materials to meet their requirements. The Forest Research Institute collected all the available information on the tanning materials, and its publication in the form of a pamphlet is very opportune. The big industrial concerns in India deal with only four tanning materials, viz., babul bark (*Acacia arabica*), myrobalans (*Terminalia chebula*), Avaram bark (*Cassia auriculata*), and black wattle bark (*Acacia mollissima*). A number of others may be of considerable value to the tanning industry. Some of them have received attention, but a large number of others have not been sufficiently investigated. It is to be hoped that the information now published will stimulate interest in the utilization of the indigenous tanning materials distributed all over the country.

Chemical Transformations of Rubber

The *British Electrical and Allied Industries Research Association*, London, has issued a very valuable review of literature on chemical transformations of rubber which lead to solid or resinous end products other than ebonite. The work forms part of a programme of co-operative research having for its objective the improvement of ebonite as a dielectric. A number of derivatives of caoutchouc—vulcanizates, cyclo-rubbers, hydro-rubbers, oxidized rubbers, halogenated rubbers, hydrohalogenated rubbers—are known. A survey of the physical properties of the derivatives, including electrical properties where known, leads to the conclusion that there is little promise of obtaining a substitute for ebonite having satisfactory electrical properties, hardness and stability. Hydro-rubber, obtained by the partial or complete saturation of the double bonds in the rubber hydrocarbon, are of some interest in this connection. During the process of hydrogenation, cyclisation often takes place simultaneously. Hydrogenated cyclo-rubbers appear to

be somewhat promising as ebonite substitutes. Cyclo-rubbers, ranging from amorphous powders to hard shellac-like products, have been produced through the use of cyclising agents, such as sulphuric acid, sulphonic acids, and halides and acids containing tin and halogen in the anion. Such products have, in fact, been produced by Staudinger and others and are likely to find application in the electrical field as ebonite substitutes.

Resin-coated Voile

Textile chemists have long emphasized the market need for sheer-weight fabrics which would also be strong and air-resistant, thus providing strength and warmth with little weight. Prior to the advent of the vinyl resin coatings, however, there was little evidence of real progress in that direction. The development of vinyl resin-coated fabrics represents one of the outstanding contributions of U.S. war-time textile processing to post-war consumer markets. One of the more interesting of these fabrics is a rayon voile, developed and produced for military use by the *Athol Manufacturing Co., Athol, Mass., U.S.A.* This very light-weight vinyl resin-coated fabric is said to have exceptionally good water and wind resistance and to provide a high degree of warmth rarely found in a sheer fabric. The coated cloth, ready for use, has a total weight of only 2 ozs./sq. yd. and it will stand 10 lbs./sq. in. hydrostatic pressure as determined by the Mullen test. At present this voile is available for development purposes only. Laboratory work indicates that it has an excellent affinity for dyes, and that, once the necessary dye chemicals are released from war work, it will be available in various colours including pastels. The coated cloth can be made in all grades of synthetic fibre or cotton, and super-strength is said to result when the voile is made of nylon. One of the largest uses to date has been for rain covers for naval officers' caps. Experiments have demonstrated its worth in such fields as women's rain wear, clothing bags, shower curtains, and moisture-resistant covers for containers for icebox use.—*U.S.O.W.I., Chem. Eng. and Chem. Newsletter*, No. 10, 1945.

Soil Conservation

Investigations carried out at the *Indian Waterways Experimental Station*, Poona, and described in the *Station's Annual Report (Technical)* for the year 1943, reveal that denudation can be effectively prevented by soil conservation. This will not only increase the productivity of the country, but also go far to prevent the building up of river beds with consequent bank erosion and floods, which in turn have adverse effects on the health of the people.

Experiments conducted at the *Station* have demonstrated that if the charge of bed material entering a river, exceeds what can be carried with the slope available, it leads to accretion and development of wide sandy beds and meandering. The Kosi River is a striking example of a river which is continually changing its course due to an excess charge of sand. All the rivers of the Punjab and Sind have been slowly, but steadily, building up their beds.

From the point of view of forestry and agriculture, denudation of soil results in damage and loss of soil fertility and productivity. It has almost always been due to over-grazing, or to disforestation for cultivation and for obtaining supplies of firewood. The Punjab was the first Province in India to tackle the question on sound lines and much has already been done there in the way of demonstration and propaganda. The worst denudation is, however, occurring in the States on the northern border of India, where control is difficult. Investigations described in the Annual Report of the *Indian Waterways Experiment Station*, show that much of the damage in the hill areas can be set right by well-maintained terracing, wind-screens, hedges to exclude animals and by planting trees and grass. In the areas with flatter slopes, terracing yields excellent results provided adequate waste weirs form part of the lay-out.

Inquiry on Balanced Diets

The present cost of a balanced diet as compared to that in pre-war years in the principal rationed towns of India is being ascertained by the Central Food Department. On the basis of the information, the Planning Section of the Department would be in a position to assess the food requirements of the people and formulate a plan for raising the nutritional standards in the country.

According to the Nutrition Advisory Committee, the composition of a balanced diet for an adult, per day, in ounces is: cereals, 14; pulses, 3; vegetables, 10; fruits, 3; milk, 10; sugar and *gur*, 2; vegetable oil or ghee, 2; fish and meat, 3; and egg, 1. As regards the last two items, a corresponding increase in the milk offtake is recommended for those who do not take meat or eggs.

Non-ferrous Metals Industry in India

Mr. Ramji Hansraj Kamani, Chairman of the inaugural meeting of non-ferrous metal manufacturers held at Calcutta on 11th June 1945, referred briefly to the problems of the industry in his presidential address. The Indian industry, he said, was not only young in age but is also small in size compared with the giant organizations in Europe and America. It should not be difficult for the foreign interests to crush the Indian industry, and if it is to survive, Government will have to consider ways and means of giving it protection.

"The present war has witnessed a remarkable development of non-ferrous industry in India. Before the war, most of India's requirements for non-ferrous metals and alloys and manufactures of the same were imported from abroad. Due to shipping difficulties and the conquest of Burma and other countries by Japan, India was called upon to rely upon her own resources to meet the Defence and other essential requirements of non-ferrous metals and manufactures. The most important problem was to refine and to utilize all kinds of non-ferrous scrap available in the country and manufacture alloys and finished goods of different kinds to the required tests and specifications for use in Ordnance Factories, Railways and other Defence and essential uses. In spite of enormous difficulties, particularly due to lack of equipment and trained personnel, the success achieved in procuring in India the defence and other requirements for non-ferrous metals and manufactures is largely due to the initiative and enterprise shown

by Indian industrialists and deserves special notice at the hands of the Government. As a result of their successful efforts, practically all available non-ferrous scrap has been utilized, thereby replacing the use of virgin metals which would have to be imported from abroad. The refining of non-ferrous scrap, the manufacture of bearing metals and castings of same, the manufacture of rods and bars of different sections and sizes of copper, brass, etc., the manufacture of rods of arsenical copper, manganese bronze and other special alloys, the manufacture of wires and cables and the production of virgin metals like aluminium, antimony and to a certain extent lead, may be regarded as the principal features of the development of non-ferrous industry in India during the war.

"Although considerable progress has been made, as briefly outlined above, during the war, there can be no two opinions as regards the scope and the necessity for further expanding and developing non-ferrous industry so as to make India largely self-supporting in non-ferrous metals and manufactures thereof. The use of non-ferrous metals is of vital importance not only in the armaments and munitions production but also for railways and industries apart for many civilian and purely domestic uses. The non-ferrous industry which should include the production of virgin metals, the refining of scrap and the manufacture of articles such as sheets, rods, wires, etc., must be considered as one of the most important key and basic industries of the country and every effort should be made to maintain this industry and further develop it to the fullest possible extent.

"No serious effort has been made so far to investigate the extent and the nature of deposits of non-ferrous metals in the country. Government should themselves undertake the investigation of all likely deposits of non-ferrous metals, and in suitable cases assist private parties to undertake the work by giving financial and other help. Government should also give every possible facilities for importing up-to-date equipment and plant from whichever countries the same could be obtained quickly and most economically to enable the existing factories to put the production on an efficient and economical basis. Similarly, wherever necessary, the Government will have also to grant special facilities for importing raw materials including scrap at concessional tariff rates till India can produce her own requirements of non-ferrous metals."

Economic Survey of Burma

It is learnt that an economic survey of Burma is to be undertaken in the near future. A number of survey committees representing British, Indian and Chinese interests and of the Burma Chamber of Commerce, the Burma Indian Chamber of Commerce and the Chinese Chamber of Commerce will shortly assemble in Calcutta. They will be furnished with particulars of the survey which they will be required to undertake. After completing these investigations in Burma, the Committees will report to the Custodian of Property under the Burma Civil Affairs Directorate. The committees will work independently of each other, and their reports will be valuable for assessing the exact state of affairs in Burma after three years of war, and liberation, and for drawing up plans of reconstruction.

Travancore

The fourteenth meeting of the Council of Research of the University of Travancore was held on 8th June in the University Buildings. *Sachivottama* Sir C. P. Ramaswami Aiyar, Chairman of the Council, presided.

Dr. K. L. Moudgill, Vice-Chairman, in his review of the work of the Department of Research, drew attention to the starting of the Statistical Bureau for teaching M.Sc. classes in the University in Experimental Statistics and for collection, presentation and analysis of data.

The Bureau is rendering statistical service to Government Departments and quasi-official institutions, and this activity is to be extended. He reported that proposals for a model salt factory and several schemes in fisheries were under the consideration of the Government as part of post-war reconstruction activities, the latter in collaboration with the Government of India.

Sachivottama Sir C. P. Ramaswami Aiyar indicated the directions in which the Government proposed to take action towards intensifying research work in the State. He recalled the assurances given to the Indian Central Coconut Committee and Rubber Production Board regarding the desire of the State in participating on expenditure-sharing basis in schemes of research sponsored or initiated by these bodies. He added that much more intensive work had to be done on the exploitation of mineral and other resources of the State, which were bound to play a very important part in the programme of industrialization of the State. He dwelt on the need for enactment of legislation for standardization of weights and measures and indicated that, unless the State, with the help of its scientific personnel, was prepared to rationalize methods of production, it would not stand a reasonable chance of establishing reputation for its products.

The Government of India have sanctioned a grant of Rs. 1,82,200 towards the recurring and non-recurring expenditure involved in the fisheries development schemes in the Travancore State for the years 1945-48.

The schemes deal with increasing the production of fish, improving the method of fish curing, exploitation of backwater fisheries, better preservation, packing and transportation.

The grant is made on the understanding that the Central Government will have the first claim on the additional production of fish, if they so desired.

Rubber Research Laboratory in the Amazon Valley

The Brazilian Government have organized a fully equipped, modern research laboratory at the *Institute Agronomico de Norte* located in Balem in the State of Para. The organization of the laboratory was entrusted to Norman Bekkedahl of the *National Bureau of Standards*, Washington, who went to Brazil in 1942 for this purpose. The work is completed and the laboratory is now in operation (*J. Franklin Inst.*, 1945, 239, 51). A small experimental factory has been set up in the jungle 5 miles from the *Institute*, where about 100 litres of latex are collected each day and processed into rubber sheets. The *Institute* is now engaged on the investigation of a wide variety of types of trees, other than *Havea Brasiliensis* and on methods of coagulation. The co-operation of the *National Bureau of Standards*

at Washington is secured for the development of improved methods of testing and grading natural rubber and for fundamental researches on rubbers of different origins and treatments. Rubber is the most important export of the Amazon Valley and whatever may be the relative positions of synthetic and natural rubbers in post-war years, the Amazon Valley will continue to be one of the most important potential sources of rubber and the work of the *Institute* will be of considerable value to the rubber industry.

Power Development in China

A vast hydro-electric power programme for China, the key project of which would be a 750' dam in the Lower Yangtze Gorge where 96 generators of 110,000 kw. each would be installed in two dozen 50' tunnels to give a total project capacity of 10,560,000 kw. with an annual output of 71,300,000,000 kw.-hrs., was outlined by John L. Savage, U. S. Reclamation Bureau dam designer on loan to the U. S. State Department. Savage returned to the United States recently after 13 months in India and China where he surveyed numerous power, irrigation and flood control projects. In addition to the Yangtze Gorge project, other Chinese projects reported upon by Savage call for an additional 2,500,000 kw. on tributaries of the Yangtze, one of which would have an installed capacity of 1,200,000 kw., and another of which would entail the highest dam in the world, about 800'. Several other Yangtze tributaries remain to be investigated, Savage said, as well as the huge Yellow River, which Chiang-Kai-Shek has asked Savage to investigate next year. (*Electrical World*, 1945, 17th March.)

Most of these dams would also entail irrigation. The Yangtze Gorge Project alone would provide irrigation water for 10,000,000 acres and a channel and locks allowing 10,000-ton ocean-going vessels to negotiate the 650 miles from the China coast to Chungking.

Savage, who has been the hydro-electric power consultant for Donald M. Nelson's Economic Mission to China, estimated the cost of the Yangtze Gorge project at \$89 per kilowatt, which would bring the total cost, not including any transmission facilities, to about \$940,000,000. He said the flow of the Yangtze is "very much more uniform" than that of the Columbia River which is known for uniform flow the year round. To achieve the 71,300,000,000 kw.-hr. output envisioned by Savage, the Yangtze Gorge units would have to be operating at capacity almost 80 per cent. of the time the year round. Maximum possible output per year from the 10,560,000 kw. would be 92,505,600,000 kw.-hrs.

The fabulous Yangtze Gorge project described by Savage is the best of five possible sites he had located by means of aerial maps. Only one of the five sites could he visit, since the others, near Ichang, were located in Japanese-held territory. To build this dam, the construction of twenty 50' tunnels for diversion of the river would be required. An additional four tunnels of the same size would be constructed, with four 110,000-kw. machines set in each tunnel at right angles to the river. The part of each tunnel beyond the turbines would serve as tail water tunnels. The generating plant would be located inside the mountain forming part of the gorge. The dam would require about 15,000,000 cu. yds. of concrete, and could be completed with 20 per cent. of the generating capacity installed

in six to seven years. The remainder could be installed in three to four years more. One hundred and forty million people live within transmission distance of the Yangtze project. Savage added that he knew of no other power site in the world whose possibilities were so great. The \$89 per kilowatt, he estimated as the cost, is considered to be conservative, but he said it was based on pre-war U.S. prices. The dam would provide 50,000,000 acre-ft. of storage, and back up a lake 250 miles long.

Other projects on which he reported are:

Ma Pien Ho River, a Yangtze tributary, a low dam with a 320,000 kw. power plant.

Ta Tu Ho River, another Yangtze tributary, would have a 500' dam with three 30' diversion tunnels running 7 km. upstream to the Ma Pien Ho reservoir with a 1,200,000 kw. plant at the end of the tunnels. The plant would be 40 km. upstream from the Ma Pien Ho plant.

Upper Chiang Ming River, a third Yangtze tributary, would have the highest dam in the world, about 800' high, with power capacity of 260,000 kw. Downstream therefrom would be a low dam with a relatively small power plant. This would protect and enlarge the 1,400 year old Quansien irrigation project whose headworks are washed out each year by floods.

Two other projects with small power plants would be located at Changshow, about 80 miles from Chungking and near Kunming.

Savage said the Chinese Natural Resources Commission had inquired about the Yangtze Gorge project some years ago in the United States, though never had any project in the United States been undertaken on so large a river. At one point in his investigation of the gorge, Savage and his party surveyed a site which was between Japanese and Chinese battle lines near Ichang. A captured Japanese aerial map, corroborated by U.S. aerial maps of the area, served as the basis for his report on the gorge.

Savage is an outstanding U.S. engineer who introduced the artificial method of cooling huge concrete masses in Boulder Dam, which he designed. Named chief designer engineer of the U.S. Reclamation Bureau in 1924, he designed, in addition to Boulder Dam, Grand Coulee, Shasta, Norris and Wheeler Dams of the T.V.A. System; Friant Dam of the Central Valley Project; Madden Dam at the Panama Canal; the Marshall Ford Dam in Texas; Imperial Dam on the California-Arizona border; Parker Dam on the Colorado River and American Falls Dam in Idaho.—*U.S.O.W.I., Civil Engineering Newsletter*, No. 9, 1945.

Indian Mica Industry

The Annual Report of the *Kodarma Mica Mining Association*, for 1944, shows that the industry, despite inadequacy of labour and machinery, has been able to produce all the mica required. The inadequate supply of mining equipment, such as air compressors and boilers, has led to a serious situation, particularly because the number of mines engaged in mining the precious mineral has greatly increased. The *Joint Mica Mission* has investigated the cost of mica production, and based on its recommendation, the Government of India have decided to increase the price of mica from May 1944. The report draws attention to the continued existence of mica thefts, although the amendments to the *Mica Control Order* prohibiting the sale of crude and bima mica have proved beneficial, illicit mica

trade is still prevalent, and in the opinion of the Association, effective prevention of theft is fundamental to the progress of the industry.

Tata Benefactions

The Trustees of Sir Dorabji Tata Trust have made a contribution of Rs. 15,000 to Sir C. V. Raman's Fund for the establishment of a Research Institute at Bangalore, under the auspices of the Indian Academy of Sciences.

A donation of Rs. 50,000 has been made to the funds of the Jamia Milia Islamia to help in the establishment of a polytechnic. Dr. Zakir Hussain, Vice-Chancellor of the Jamia Milia, in accepting the gift at a luncheon given at the Taj Hotel (22nd June), said "it has been stated that everything Tatas touched turned into gold. What he admired, however, was their rare gift of knowing how to put that gold to use for social purposes and humane ends. The presence of several distinguished persons on that occasion and the encouraging response given to the Jamia Milia's appeal for funds was construed by him as recognition of the Jamia's efforts to attain in education a diversity in place of the present drab uniformity and as appreciation of the work of those to whom education was not a mercenary job but a mission and a calling with its own traditions and values."

Fishing Industry in Bombay

The Government of India have sanctioned a grant of Rs. 61,500 towards half the expenditure of two fishing schemes in Bombay for the year 1945-46. The schemes deal with stocking tanks with carp fry, deep tanking experiments, and shark fishing with power-propelled vessels.

Agricultural Statistics

The Government of India have sanctioned a grant of Rs. 3,00,000 to meet two-thirds of the cost of a scheme for improving the methods of collecting agricultural statistics in Orissa during the year 1945-46. It is understood that the Central Government will not continue the grant to the Provincial Government at this rate in future years and that the aim would be to make the entire cost of the scheme a charge on the provincial revenues.

Announcements

Lady Tata Scholarship Awards. The Trustees of the Lady Tata Memorial Trust have announced the award of the following scholarships and grants for the year 1945-46:—

International Awards for research in diseases of the blood with special reference to Leucæmias:—

Dr. P. A. Gorer (London), Grant £70; Dr. A. H. T. Robb-Smith (London), Grant £100; Dr. Werner Jacobson (Cambridge), Grant £300; Dr. (Miss) P. Hammick, to work under Prof. Witts to confirm Dr. Jacobson's research, Grant £400.

Indian Scholarships of Rs. 150 per month each for one year from 1st July 1945, for scientific investigations having a bearing on the alleviation of human suffering:—

Mrs. Alamelu Venkataraman, Synthesis of Sulfanilamide derivatives, Haffkine Institute, Bombay; Mr. S. Dattatreya Rao, Investigations on the Synergy between Vitamins A and E and functions of Carotene and Vitamin A in the Animal System, Indian Institute of Science, Bangalore; Mr. L. D. Sanghvi,

Genetical study of blood groups and diseases with special reference to malignant tumours and Erythroblastosis Foetalis in Bombay, Tata Memorial Hospital, Bombay; Mr. T. A. Venkitasubramanian, Synthesis of Antiparasitic agents against tropical diseases other than malaria with special reference to Amœdines and Organometallic Compounds, Maharaja's College, Ernakulam; Mr. G. Balasubramanyam, Insulin Derivatives and Carbohydrate Metabolism, Indian Institute of Science, Bangalore; Mr. T. K. Wadhawani, Mechanism of the mottling of teeth, Indian Institute of Science, Bangalore; Mr. Rabindra Kumar Basu, Synthesis of Vitamin C (*l*-ascorbic acid), University College of Science and Technology, Calcutta; Mr. Kalipada Mukherjee, Research on Food Yeast, Biochemical Laboratories, University of Dacca, Dacca.

University Grants Committee.—A recent notification in the *Gazette of India* announces the appointment of a University Grants Committee on the lines suggested in the Sargent Report on post-war education in India. The members of the Committee, who will hold office for five years, are: Sir Mirza Ismail, Prime Minister, Jaipur State (*Chairman*), Mrs. S. N. Ray, M.L.A. (Central), Sir V. N. Chandavarkar, M.L.A. (Central) and Dr. W. A. Jenkins, I.E.S. (Retired) (*Members*.)

The Committee will, in the first instance, deal in a consultative and advisory capacity with the Universities which are central subjects, namely, Aligarh Muslim, Benares Hindu and Delhi Universities. The Committee will make enquiries and recommendations regarding (1) the lines on which the universities should develop; (2) the additional amounts in the form of grants-in-aid from public funds required; and (3) the co-ordination of their activities with a view to avoiding unnecessary overlapping.

H. H. The Maharaja of Baroda has appointed Sir Cyril Fox to prepare a geological and hydro-electrical survey of the State. Sir Cyril has been asked to draw up a development scheme in the light of his findings.

Indian Railway Conference Association.—Dr. D. R. Malhotra (B.B. & C.I. Railway), has been re-elected Chairman of the Metallurgists and Chemists Sub-Committee for the year 1946. The next

meeting of the Sub-Committee will be held in Bangalore in February 1946.

The All-India Manufacturers' Organization.—At the first Quarterly Meeting of the Central Committee held in Bombay on Sunday, 17th June 1945, the following members of the Organization were elected Office-bearers of the Central Committee for the year 1945:—

Sir M. Visvesvaraya, K.C.I.E. (*President*); Mr. Sankalchand G. Shah, Sir Gokulchand Narang, and Dewan Bahadur H. L. Kaji (*Vice-Presidents*); Mr. H. P. Merchant (*Hon. Treasurer*); Dr. L. C. Jariwala, Mr. Murarji J. Vaidya, and Mr. N. D. Sahukar (*Hon. Secretaries*).

Council of Scientific and Industrial Research.—To encourage the economic use of firewood in view of the acute scarcity of fuel in the country, a reward of Rs. 2,500 is offered by the *Council of Scientific and Industrial Research* for the best design of a simple, cheap and efficient domestic fireplace for burning firewood which will generate the maximum heat with the minimum consumption of fuel. Applications with details of the designs and drawings should reach the Secretary, Council of Scientific and Industrial Research, not later than the 20th January 1946. The designs and drawings which will be submitted shall not be returned, and the approved design or designs with drawings shall be the sole and exclusive property of the *Council of Scientific and Industrial Research*. Further details can be obtained from the Secretary, Council of Scientific and Industrial Research, The Mall, Civil Lines, Delhi.

The *Council of Scientific and Industrial Research* have recently selected Messrs. **Shaukat Rai** and **A. P. Kanvinde** for architectural training in the design and construction of scientific laboratories and factories in the U.S.A.

Mr. Ziaul-haq-Siddiqi of the Osmania University, Hyderabad (Deccan), has also been selected for technical training abroad in ceramics.

The candidates are expected to leave India shortly for necessary training.

Erratum.—July 1944, Vol. IV, No. 1, page 58, right hand column, line 7:
delete "of parasites."

VICTORY AND PEACE

As we go to press, the welcome news of the surrender of Japan has been received. The nightmare of war is over, and peace which had suffered a blackout for nearly six years over a large part of the globe, has now dawned. The world at large has received the news of the defeat of the last of the aggressors with relief. The war that has just ended brought into action numerous weapons

of destruction that science and human ingenuity could devise, and it has shown beyond all doubt that aggression does not pay. The time for translating the Atlantic Charter and the Four Freedoms into action has at last arrived, and it is the hope of the common man that the peace to come would be both enduring and just.

Indian Patents

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for the period May–June 1945.]

31577. LIQUID ALKYLATION CATALYSTS : *Olefine is contacted with isoparaffin in the presence of a liquid catalyst.*—Anglo-Iranian Oil Company, Limited.
31637. CONCENTRATION OF IRON ORES : *Treating ore with an anionic collecting agent and with co-operating agents and subjecting to froth flotation, treatment.*—Minerals Separation North American Corporation.
31743. PYROGALLOL : *Heating gallic acid to melting in a closed vessel and then subliming in a condensing chamber attached with the closed vessel by means of side tubes.*—S. P. Sen and others.
31808. ELECTRICALLY CONDUCTIVE COMPOSITION : *Comprising a matrix material in solid form and finely divided carbon dispersed throughout.*—The Honorary Advisory Council for Scientific & Industrial Research.
31975. LOW OIL CONTENT LOAD BREAKING SWITCH : *Low oil content load breaking or overload current interrupting switch.*—Electric Transmission, Limited and others.
31991. SPARKING PLUGS : *Sparking plug having projecting part of insulator reduced in length and wherein the shell or casing permits a box spanner to turn it.*—Simmonds Development Corporation, Limited.
28794. ISOMERIZATION OF HYDROCARBONS : *Treating hydrocarbons with a liquid catalyst.*—Shell Development Co.
30062. ELECTRODEPOSITION OF TIN AND ITS ALLOYS : *Electrolyte containing a sulphonyl compound.*—Carnegie-Illinois Steel Corpn.
30063. ELECTRODEPOSITION OF LEAD : *Electrolyte containing benzene disulphonic acid and a sulphonyl compound.*—Carnegie-Illinois Steel Corpn.
30538. APPARATUS FOR DETECTING AND INDICATING AND/OR MEASURING ICE FORMATION ON VEHICLES : *Sound emitter mounted in spaced relationship with a receiver on the surface.*—Tecalemit Ltd.
30574. FILLING DEVICES FOR TANKS, SUMPS AND THE LIKE : *Filter body with screen with hinged bridgepiece closure and fluid tight joint with an air vent.*—Vokes Ltd.
30965. METHOD AND MOULD FOR CENTRIFUGAL CASTING : *A plurality of similar superimposed, concentric, individual moulds clamped into one rotating and pouring unit.*—Ford Motor Co. of Canada Ltd.
30966. IMPROVEMENTS IN AND RELATING TO THE MAKING OF MOULDS FOR CASTING, TO MOULDING APPARATUS AND TO MOULD PATTERNS FOR USE THEREIN : *Pattern having pivotally connected sections and corresponding to the re-entrant projection made flexible and independently removable from its mould cavity.*—Ford Motor Co. of Canada Ltd.
30973. ACCESSORY FITTINGS FOR LIQUID CONTAINERS, AND MEANS FOR SECURING SAID FITTINGS THERETO : *Secured to the lower end of a substantially rigid tubular housing whose two ends secured to liquid container, and provided with aperture for float arm.*—I. C. I. Ltd.
30984. FURAN FROM FURFURAL : *Reacting in the vapour phase furfural and steam in the presence of a catalyst.*—E. I. du Pont de Nemours & Co.
31095. CLEANING MOVING SIFTING SCREENS : *By reciprocating brush means, guided by two cams on either side of guide track.*—Max Koller & Co.
31315. FLOWING OF A METAL COATING APPLIED TO A METAL STRIP : *Heating the coated strip electrically and then cooling.*—Davy and United Engineering Co., Ltd.
31408. CONVERTING DIRECT CURRENT INTO ALTERNATING CURRENT : *Rotary shaft having two sleeve with projections entering into, but insulated from each other, and two pairs of brushes.*—C.L. Mullick.
31464. CYLINDRICAL THERMIONIC VALVES : *Surfaces of electrode are pair of coaxial cylinders joined at one or both ends by annular member.*—The M-O Valve Co., Ltd.
32017. IONIC EXCHANGE OPERATIONS : *Purification of solution by ionic exchange treatment the process is carried out in an exchanger unit, arrangement for reactivation and control of solution level being provided.*—The Dorr Co.
32048. EQUI-SIGNAL RADIO BEACONS : *Equi-signal radio beacon with means for maintaining optimum sharpness over the whole range of discrimination.*—Marconi's Wireless Telegraph Co. Ltd.
32087. IMPROVEMENTS IN AND RELATING TO X-RAY CONTROL APPARATUS : *Tapping voltage proportional to logarithms of milliampere time values.*—Philips Lamps Limited.
32113. PROTECTION OF STEEL, PARTICULARLY STRUCTURAL STEELWORK AGAINST HEAT : *Protection of structural steel from heat by shrouding the metal by non-inflammable element or compound which absorb heat by undergoing physical or chemical change.*—The Chemical & Insulating Co., Ltd.
29784. ELECTRONIC DISCHARGE AMPLIFYING ARRANGEMENTS : *For feeding two or more antennae with currents of different phases.*—Standard Telephones and Cables Ltd.
30977. TUBULAR HEAT TRANSFER APPARATUS : *Closure member for clean-out openings.*—The Superheater Company Ltd.
30991. SPUR GEAR DRIVE TRANSMISSION : *Driving and driven super wheels are engaged by an intermediate wheel.*—The Austin Motor Co., Ltd.
31022. PIANOGRAPHIC PRINTING PLATES : *The plate being formed of two superposed sheets of parchmented cellulose.*—Addressograph-Multigraph Corpn.
31054. CLAMPING DEVICE FOR SECURING AN ELECTRIC INSULATOR IN A METAL PLATE, FOR HOLDING PIPE ENDS TOGETHER AND FOR OTHER PURPOSES : *A ring member having a base and a flange approximately at right angle with strips sliding inwards through slots and screws passing through the base of the ring.*—W. T. Henley's Telegraph Works Co., Ltd.
31055. IMPROVEMENTS IN OR RELATING TO THE MAKING OF JOINTS IN, OR REPAIRS TO, ELECTRIC CABLES : *Bringing together adjacent ends of*

- a thermoplastic insulating covering, subjecting to pressure in a mould and weld by heating by High Frequency electric current.*—British Insulated Cables Ltd.
31064. RECOVERY OF WAX-LIKE PRODUCTS FROM THE FLESH OF SISAL AND LIKE PLANTS: *Treating with an organic solvent, separating and then distilling off the solvent.*—African Sisal & Produce Co., Ltd.
31085. MANUFACTURING SHIMS: *Superimposed layers of metal foil stuck together by means of an organic adhesive.*—Roe.
31220. BENEFICIATION OF OXIDIZED IRON ORES BY FROTH FLOTATION: *Treated with acid and oil soluble petroleum sulphonates.*—American Cyanamid Co.
31379. CARBURETTING APPARATUS FOR INTERNAL-COMBUSTION ENGINES: *Fuel atomizing device, reservoir and means communicating the reservoir to cylinder inlet.*—Lempke.
31410. FLUID FLOW CONTROL DEVICE: *Resilient tube seated on annular surface of a barrier which has a circular shoulder on its periphery.*—Grove and Grove.
31785. EXHAUST VALVES OF THE POPPET VALVE TYPE OF INTERNAL COMBUSTION ENGINES: *Shroud located in exhaust passage and surrounding valve stem.*—The Austin Motor Company Limited.
31797. CENTRIFUGAL PUMPS: *Branch connected to suction pipe, non-return and auxiliary valve and chamber for priming water.*—Pulsometer Engineering Co., Ltd.
31828. SHELLAC ADHESIVE FOR BONDING PLYWOOD: *Comprising shellac, spirit, urea, formalin, aluminium chloride, kaolin and saw-dust.*—The Indian Lac Cess Committee.
31842. WEAVING LOOMS: *Buffers or frogs when actuated by the warp protectors, effect shift of warp yarn beam mounted for bodily shift parallel to its axis.*—Cargill and Galloway.
31987. GRAVITY OPERATED CLOCKS: *A ratchet pinion engaging a fixed vertical rack and driving clock-work.*—C. J. B. De Kurowski.
30609. IMPROVING BLAST FURNACE OPERATIONS: *Automatically varying the temperature of the blast according to its humidity.*—U.S. Steel Corp. of Delaware.
30715. ASH TRAYS: *Tray and a coiled element.*—Holman.
30769. CLOSURES FOR INSPECTION AND LIKE OPENINGS SUCH AS IN THE STRETCHED SKIN FABRIC OF AIRCRAFT COMPONENTS OR OTHER STRUCTURES: *Annular flange having circumferentially spaced locking members and closure member of disc form having circumferentially spaced securing means.*—Ford Motor Co. of Canada, Ltd.
30791. IMPROVEMENT IN PROTECTIVE COATINGS: *Coating with an emulsion of polyvinyl alcohol in water.*—Ford Motor Co. of Canada, Ltd.
30926. POLY SPEED A. C. MOTOR: *2 Stators and one common rotor.*—Karandikar.
31031. TYPE FOUNT FOR PRINTING URDU AND THE LIKE SCRIPTS: *Characters which extend lengthwise are reduced and characters having rounded body anticlock-wise are in two forms.*—S. Mirza.
31033. RELEASE HOOKS FOR AIRCRAFT: *Closed hook, means for attaching it to aircraft and means for automatically releasing launching rope.*—Leslie.
31049. PRE-STRESSED CONCRETE SLEEPERS: *Parallel reinforcing wires are placed under tension, and supply of empty moulds and removal of concreted moulds are effected by transverse conveyors.*—Bernier.
31051. COUPLINGS FOR HOSES AND PIPES: *Ferrule collar and union nut in two parts.*—Tecalemit, Ltd.
31083. SURFACE LUBRICATION OF METAL PRODUCTS: *Depositing lubricant-in-water emulsion, washing it with water and drying.*—Carnegie-Illinois Steel Corp.
31097. SOLVENT EXTRACTION PROCESS: *Separating mixture of two compounds by extraction with a selective solvent consisting of sulfolene.*—Shell Development Co.
31105. THERMOSETTING SYNTHETIC RESINS BY THE POLYMERISATION OF ALKYLENE OXIDE DERIVATIVES: *Ethylene oxide derivative which contains at least 2-ethylene-oxide groups is polymerised.*—De Trey Freres Societe Anonyme.
31156. REFRIGERATING APPARATUS: *Refrigerant supply and discharge connections all on the rear faces of the vertical stacks of plates.*—General Foods Corp.
31259. PNEUMATIC CONTROL DEVICES, MORE PARTICULARLY FOR USE IN COMBINATION WITH WEIGHING APPARATUS: *Means associated with weigh-beam interrupts pneumatic jet.*—W. & T. Avery, Ltd.
31267. VARIABLE SPEED GEAR: *Main shaft and countershaft are supported at each side and in immediate vicinity of constant mesh gears.*—Guy Motors, Ltd. Andrews, Gilbert and Reece.
31334. HUSKING MACHINES FOR PADDY OR LIKE CEREALS: *Cylinder having inlet and discharge openings, rotatable shaft having screw and blades, and weighted flap for discharge opening.*—Ghatak.
31805. A PRESS FOR MAKING OVER BUTTONS: *Buttons of two metal pieces, top one covered with cloth along with bottom piece placed in a press having male and female die and secured by hammering.*—Lily Moulds Button Wks.
31871. RUBBER ARTICLES: *Conical cylinder with coagulating tank, hollow screw spindle, and two tanks containing latex and co-agulant.*—Chadray.
31912. VAPOUR BURNERS: *Single turn vapourising coil supporting a disc mixing tubes and perforated cap.*—Zimmerer.
32100. GLUCOSE: *Heating starch to make it swollen and readily hydrolysable for converting to glucose.*—The Standard Pharmaceutical Wks. Ltd.
30758. BELTING: *Single ply textile fabric of coarse yarn.*—Dunlop Rubber Co., Ltd.
31036. BULB LOCKING DEVICES: *Two tubular elements movably relatively only in one direction.*—Matharu.
31041. ELECTRIC SELECTION CONTROLLING CIRCUITS: *For controlling the numerical selecting operation of selector switches.*—Standard Telephones and Cables Ltd.
31042. SELECTION CONTROLLING CIRCUITS FOR AUTOMATIC TELEPHONE EXCHANGES (addition to No. 31041): *Controlling numerical selecting operation of selector switches.*—Standard Telephones and Cables Ltd.
31044. SELECTION CONTROLLING CIRCUITS FOR OPERATING SELECTOR SWITCHES (addition to No. 30008): *Selector device with two vacuum tubes in register comprising switch.*—Standard Telephones and Cables Ltd.



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RESEARCH SERVICE FOR MINOR INDUSTRIES

THE provision of research service to Indian industry has aroused considerable interest during the past few years. There is an overwhelming volume of opinion in favour of the rapid expansion of research facilities, as the value of a well planned research service for the promotion and advancement of industry has been amply recognized. The nature of the service and the machinery required for bringing the benefits of research to the various classes of industry demand careful consideration. The so-called "big business" is keenly alive to the value of research and it has the means by which it can obtain for itself, without fully depending on any external agency, all its essential requirements. "Co-operative Research Associations" and "Industrial Fellowships" are two tried systems which have been successfully adopted in industrially advanced countries, which are within the means of medium-sized industries. The third category of industries, viz., cottage or minor industries, which although individually small are collectively of considerable magnitude, are disadvantageously situated, and considering that they occupy an important place in the economic structure of the country, the provision of an adequate research service to cottage industries demands the attention of the Government and leaders of science.

The organization, development and improvement of cottage and small-scale industries require enlightened consideration, as these industries promote the well-being of multitudes by providing employment to a large number of men and women in gainful

occupations over a wide region. They serve to relieve the excessive dependence on land in rural areas. In the recent past, they contributed impressively to the war effort and supplied a variety of goods required by the civilians when normal imports were cut-off and local production was diverted to meet the demands of war. Their survival in a competitive world can be ensured, and their scope for social service enhanced only by organizing them on progressive lines. An eminently workable scheme* for rural industrialization has been recently prepared by Sir M. Visvesvaraya which envisages the grouping of villages into convenient units. The adoption of this scheme will provide the minor industries with the organizational set-up on a regional basis necessary for their advancement. It must be remembered that the requirements of small industries are essentially similar in range to those of the medium and big industries, and include a properly organized research service. New raw materials, alternative methods of processing, labour-saving devices, standardization, quality improvement of products, all these need to be inquired into and involve problems which do not yield to traditional methods of approach; they need the attention of experts.

The minor industries provide a striking parallel to agriculture. The advancement of both is determined, almost entirely, by the nature and extent of the assistance rendered

* All-India Manufacturers' Organization, Bombay, Brochure No. 2, 1945.

to them by Government. Improved seeds, fertilizers, methods of stock breeding and other scientific practices are steadily, though slowly, infiltrating into rural agriculture as a result of the researches conducted by Government Departments of Agriculture, and propagated through experimental farms by a host of trained agricultural demonstrators. The methods adopted for improving agriculture are applicable to the minor industries also. The Departments of Industries, by strengthening their research divisions, can and ought to promote the cottage and minor industries. What is needed is a network of laboratories in all the Provinces and States, and what is equally important, the organization of a research information service, which will convey to the craftsman in the language which he understands, technical information which he can readily utilize for improving his craft. The need for a research service even in an advanced country like America has been emphasized by Maury Mavrick, who was till recently Chairman of the Smaller War Plants Corporation of America, in the following words, "One of the things that American small business needs is technical assistance in a manner comparable to that

given to farmers by the Department of Agriculture." Mr. Henry A. Wallace recently stated, "For more than 40 years, the Department of Commerce has had a research division called the *Bureau of Standards*. Its activities were greatly stimulated by Herbert Hoover when he was Secretary of Commerce. The *Bureau*, nevertheless, remains only the tiny nucleus of the vast array of laboratories and scientists that could make its research services to business the equivalent of the research services that the scientific bureaus of the Department of Agriculture render to farming." He points out that the Government should "give to millions of small businessmen the same opportunities to keep abreast of new scientific developments that it now gives to millions of small agriculturists."

The organization suggested by Sir M. Visvesvaraya is well adopted to take upon itself the responsibility for propagating research information, but the investigational work is the special responsibility of the Government. Skilled and imaginative planning by Government in this field is sure to yield valuable results which will benefit millions of people and raise the economic, moral and cultural status of the common man.

EXPANSION OF GEOLOGICAL SURVEY

DETAILS are now available of the Central Government's scheme to expand the Geological Survey of India to enable it to undertake extensive exploration of the country's mineral and water resources, and thus assist post-war plans for industrial and economic development.

The primary function of the Survey is the preparation of a geological map which provides the basis for all other geological work. Equal importance will now be given to mineral development and economic geology. Under the scheme now planned, the functions of the Survey will cover : (a) preparation of geological maps, (b) economic geology, (c) engineering geology and water-supply, (d) geophysical work and (e) dissemination of information.

For these purposes the existing Mapping Circles will be adequately increased, and two new circles, one for Mineral Development, and the other for Engineering Geology, will also be added. The Mineral Development Circle will consist of officers who have specialized in the study of certain minerals such as coal, mica, manganese, clays, gypsum, etc., and

those in the Engineering Geology Circle will be specialists in the geological investigation of damsites, water supply or any geological problems relating to engineering.

It is pointed out that if the Department has to perform these diverse functions, expansion in the strength of the Survey is inevitable. The cadre of the geological officers, which was hardly 30 during pre-war days, will, under the expansion scheme, be raised to 125 as soon as possible. This figure is only the present target and it may be necessary to increase the strength further. Besides, the required complement of geophysicists, mining engineers, chemists, etc., will also be provided as rapidly as possible.

The field activities of the Geological Survey can be adequately completed only if there are available suitable laboratories, a scientific library, a museum, a drawing office, and adequate facilities for chemical, mineralogical, petrological and palæontological work. Plans will be prepared for their extension and modification so as to bring them into line with the expanded activities of the survey.

COMMERCIAL VALUATION OF PATENTS

By J. N. SEN-GUPTA

(Council of Scientific and Industrial Research, Delhi)

IN India we have yet to develop an organized and well-informed market for patents. But this can be done only by removing the prevailing prejudices that valuation of patents is done by entirely arbitrary methods and that the prices actually offered for them depend on the accident of the holder of a patent coming across a willing buyer and the degree of the readiness of the latter to take a gambling chance. In specific cases of private deals, this may be true as of any commodity lacking in an organized market, and it should be no matter for surprise if the comparatively low prices offered for patents in India *vis-a-vis* those offered for patents in the U.K. and the U.S.A. tend to confirm this suspicion. Yet, scientifically speaking, it is not true to say that the sale or licensing of patents follows entirely the rule of thumb and is not regulated by any rational economic principles. The following paragraphs will indicate that the contrary is the case, although there is no set formula for general application in the matter and intelligent surmises based on judgment and experience have to play an important part in dealing with specific cases.

The commercial value of a patent, which confers the advantages of a monopoly, limited by its life (16 years in British India), is to be traced to one of the following: the invention may bring into use an entirely new article not previously known; or it may relate to a new method of manufacturing a known article at a *lower cost*; or it may relate to a new method for producing a *better quality* of the known article at the same cost; in each case undisputed novelty is the *sine qua non* of obtaining a patent for the invention.

It is easier to assess the commercial value of the patented invention in the last two cases than in the first. The "lower cost" might be due to a substantial economy either in the cost of machinery employed or in the working expenses, as compared to the known processes of manufacture, and this should be measurable, as much as the value of an invention for producing "better quality" of articles already in use which would fetch better prices. In both cases the effect would

be registered in an increase in the net profits. It is, however, extremely difficult, if not impossible, to make a precise assessment of the commercial value of the patented invention in any of the cases stated in the foregoing paragraph, for the entire life of a patent. Still some *a priori* calculations have got to be made to settle the terms of its sale or lease. Thus in the case of a new article, for the first time brought into existence by a scientific invention, it should be possible to make an estimate of the cost on the basis of pilot plant experiments, and also of the probable annual demand with reference to comparable imports and local manufactures after a careful appraisal of the importance of the article in question and its potential uses. A demand price has then to be estimated with reference to the comparable articles or those meeting comparable needs, and according to the principle of "what the traffic will bear," to yield the maximum net returns. Thereafter the net annual profits are to be calculated as follows: $\text{Output} \times \text{Price} - \text{Cost}$. If the profits are multiplied by the time-spread or life of the patent during which it will be effective as a monopoly, the resultant figure would measure the value of the patented invention. Likewise in the case of the "improvement" patents the valuation may be done by multiplying the *excess* of net profits *directly attributable to the new invention* (as compared to similar articles already in use) by the number of years during which the patents would continue to be effective. As stated by Haddan, the estimated commercial value of the invention is "the value of the superior efficacy of the invention over the best of its competitors, in each instance of its employment, multiplied by the number of instances of its employment or likely employment, and the time during which it is likely to have pre-eminence."*

In stable economic conditions, the value as calculated above would tend to be identical with the price of the patent assuming that there would be no defects in drawing up the specifications and the latter would

* *Compendium of Patents and Designs* by Reginald Haddan, 1931 Edn., p. 37.

fully cover the commercial advantages expected of the invention. But the factors involved are far from stable and each of them is essentially so dynamic in character that the purchase of a patent is almost everywhere regarded as a highly speculative investment. It is impossible to foresee if the effectiveness of the patent would continue unimpaired during the entire period of its life. Its utility might, indeed, diminish or even disappear on account of a change in fashion and the resultant obsolescence or, what is more probable, the appearance in the field of a rival invention offering greater economic advantage. Nobody can foretell when and how early even during the life of the patent this may happen. The fixation of the price of the patent at the estimated value of the invention would thus involve extreme hazard and would hardly be tenable unless, as must be very unusual, such hazards are fully covered by a guaranteed market and the investor is satisfied, particularly in the first case (invention of a new article), with earning merely the interest on capital. In actual practice a substantial deduction has to be made from the estimated value in fixing the price of the patent as an offset against the attendant risks and to provide the necessary inducement to the buyer.

Before examining the economic implications of this phenomenon it is well to point out that the price or value is not always or even commonly paid down or demanded as a single lump sum. There are several methods of realizing the value and these have been evolved to suit the needs of individual cases. The characteristic features of these methods are briefly indicated below:—

1. *Sale or Licence for Single Premium.*—This method is based on the assumption of the effectiveness of the patent as a monopoly for a definite period, equal to or shorter than its life, and the sustenance of the net earnings at a certain level. In essence the premium represents the consolidated total of the calculations of annual royalty on exploitation for the effective period with a regressive calculation of interest thereon. Evidently, it involves great speculative hazards. The apparent simplicity of the method is the only point in its favour because it avoids, as in the case of outright sale or assignment, the necessity of continuous transaction between the licensor and the licensee, with obligations on the part of the latter for maintaining and furnishing sales accounts at regular intervals for inspection

by the licensor. It can attract the investor either when he is more optimistic than the holder of the patent about the potentiality of the invention, or if he is assured of a market for immediate exploitation and to such extent that he can earn sufficient profits to cover his investment without worrying about the long-term prospects; or if the price of the patent is fixed much too below the estimated value of the invention, i.e., at a nominal level; the decision of the buyer or the licensee will, of course, be influenced considerably by the amount of the capital investment required. From the wider social or national point of view this method can hardly commend itself as one for general application. If the buyer or the licensee loses, patents would come to be regarded with suspicion and the market would shrink; if, on the other hand, he reaps a rich harvest of profits the inventor would consider himself to be a victim of exploitation and this might, in the prevailing conditions, have an inhibitive effect on fresh research.

2. *Royalty on Profits (Net).*—This method has a *prima facie* reasonableness on account of the speculative character of patents and is bound to be preferred by the licensee in respect of such cases as involve comparatively great risks which the buyer would like to share with the holder of the patent (licensor). In actual practice, however, this method is likely to bring in numerous complications. It is not enough to provide that the royalty payable to the licensor should be calculated as a certain percentage of the net profits. A speculative investment would naturally carry with it the demand for certain minimum profits—in addition to the interest on capital—before claims for royalty should arise. Even more serious than this complication is the one that is bound to arise from the difficulty of controlling possible manipulation of net profits by the licensee, by all sorts of devices for showing expenses at an inflated figure. Such a method, therefore, would retard rather than help a progressive and healthy expansion of the commercial development of patents, and it can be applied with necessary safeguards only to very extraordinary cases, such as would not otherwise attract the investment of private capital.

3. *Royalty on Value of Sales.*—The fixation of the royalty as a percentage of the value of periodical (annual, half-yearly or monthly) sales is free from the complication of the

method previously referred to, and it minimizes speculative hazards on both sides; at the same time, it keeps the chance open for both the licensor and the licensee to share proportionately in the benefits of an expanding market for the article, should the invention prove to be a success of enduring and even increasing value. Like the previous method, but without the complications thereof, it is fair to the licensee in that it would subject the latter to a claim for royalty only so long as the manufacture is continued, presumably at a profit. It has, however, an obvious drawback as the licensee may already be interested in some process producing a competitive article and may prefer to bottle up the new patent. But such a contingency can be obviated by inserting necessary provisions in the licence that it would be open to the licensor to cancel the licence in case the licensee fails to undertake commercial development of the invention within a stipulated time.

4. *Royalty on Volume of Production—Per Unit.*—This is indeed a variant of the preceding method—as being fixed initially on the basis of a presumed value—and has to be adopted, as a matter of preference, in particular cases on practical considerations. The preceding method applies very well to cases where the process leased out relates to the manufacture *in toto* of a marketable article. If, however, the process relates to the improvement of just a part of the article, and the part is not offered or available separately for sale in the market, the royalty could not possibly be correlated with the sale price of the finished article at a fixed percentage; for, the sale price of the latter may be affected by numerous factors apart from the particular part in question, and the part may account for just a fraction of the value of the finished article. In such cases the fixation of the royalty per unit is likely to be considered as the most reasonable method.

It is not unusual, however, to find this method being applied to articles manufactured *in toto* according to the patented process, in preference to the previous method. Evidently, in such cases the incidence of the royalty must vary according to the fluctuating prices of the articles in question, and the royalty may prove a hindrance to production if the article is confronted with serious competition bringing about a steady fall in prices. On the other hand, the licensor may lose if monopoly considerations tend the

licensee to restrict output for obtaining the maximum net profits.

5. *Initial Premium plus Royalty on Sales.*—This, as a *via media* between the two methods already described, may be deemed suitable for certain cases as a compromise between the considerations which weigh most with the licensor and the licensee. To the licensor the initial premium provides an assurance that having incurred a substantial expenditure on this account the licensee will set himself to the task of commercial exploitation of the patent in all earnestness. He also gets an immediate payment of the value in part which would cover to some extent the expenditure involved in the inventions and which the licensor would welcome in cases where he is chary of relying entirely on long-term prospects. The immediate advantage is counterbalanced by a proportionate reduction in the recurring royalty which he would otherwise claim. The licensee, however, would prefer this method only when he is inclined to take an optimistic view of long-term results and his calculations point to a net saving in the price arising from a lower royalty conditioned by payment of an initial premium. The premium, of course, is non-refundable.

As a commercial proposition this method has a very strong point in its favour. A patent has a limited life and its value as a monopoly expires after that period. In the realization of this value the time factor involved in an expeditious and continuous exploitation of the patent must necessarily be reckoned as one of prime consideration. If the licensee cannot or does not undertake exploitation within a reasonable period, there would be a resultant loss to the licensor for the time wasted, even if the terms of the licence contain provisions for cancellation of the licence for the licensee's omission or failure in exploitation within the stipulated time. The contingency of such a loss is avoided by the method of an initial non-refundable premium *cum* recurring royalty on sales. The appeal of such a method to the licensee, however, must vary in inverse ratio with the amount of the premium claimed if there are uncertainties about the success of commercial exploitation.

Now regarding the economic implications of the divergence between the estimated value of the invention and the actual price of the patent, it is evident from the foregoing description of the various methods

that the fact of their remaining simultaneously in vogue is attributable mainly, if not entirely, to the varying element of risk involved in the commercial exploitation of patents, as viewed from the standpoints of the licensor and the licensee respectively. If the risk were a constant factor for the life of the patent, it would be possible to formulate the terms according to the various methods on a common basis of expected net profits; indeed, the methods in such case would be quite interchangeable and the choice between them would be only a matter of convenience for the realization of the identical value. As a matter of fact, however, quite different views might be taken by the buyer and the seller in respect of the risk involved in the development of the invention on a commercial scale, and they might, accordingly, be actuated to insist on payment of the value by a particular method. If the risk element could be smoothened out by any formula that would meet the points of both parties, a common ground between the two would be created, ensuring, at the same time, the realization of a value that should be considered fair to both. For instance, if for a particular invention the licensor demands either a single premium as Rs. *A* or a royalty of Rs. *B* per unit and the buyer offers a royalty of *C* per cent. on sales value or *D* per cent. on net profits, according to their respective assessment of the risk and its effect on probable profits, then a royalty calculated as the average of all the four terms, i.e., $\frac{1}{4} (A+B+C+D)$ should be

considered the fairest as bringing down the risk to the minimum level acceptable to both sides. But the method of payment of the value according to such a comprehensive formula would appear to be cumbrous from the administrative point of view. In actual practice, therefore, it may be necessary to simplify the calculations by compounding only such methods as are absolutely essential to satisfy the parties. The method of an initial premium *cum* royalty on sales is one based on such compromise, which accounts for its growing popularity. It is in the matter of giving weightage to the various considerations involved that the incalculable factor comes in and reliance has to be placed on cautious judgment and mature experience.

It would, therefore, be well to bear in mind the element of risk as such involved in the various methods as viewed from the standpoints of both the buyer and the seller. (See table below.)

In regard to the actual quantum of value to be realized by the licensor, one important consideration to be borne in mind is that royalty is essentially a charge on estimated profits. Even after payment of the royalty the net profits earned by the licensee must show sufficient margin over standard profits of industries to provide the necessary inducement for a speculative investment, and this margin must expand proportionately with the degree of the hazard involved. Even in a country like the United Kingdom which

	From Seller's Standpoint	From Buyer's Standpoint
1. Single premium	Welcome as eliminating risk and assuring immediate payment of consolidated value of net profits for the effective life of the patent.	Maximum risk in the absence of any exceptional advantage in the form of guaranteed market.
2. Royalty on Sales Value ..	Risk of non-exploitation and loss for wasted time in cases of cancellation of licence. Possible inhibitive effect on invention in such contingency.	Welcome as eliminating the risk of a payment in advance.
3. Royalty on Production Unit	Do.	Risk of overpayment in times of fall in prices to uneconomic levels.
4. Royalty on Net Profit	Risk of evasion of royalty for absence of control over manufacturing expenses and resulting prejudice to scientific invention.	Welcome as eliminating risk of payment in adverse conditions of the industry.
5. Premium plus Royalty on Sales.	Welcome as minimizing the risk of non-exploitation.	Risk, necessarily involved in prepayment, is reduced by the combination.

has the advantage of a fairly developed market for patents backed by an easy flow of industrial capital, a return of 10 per cent. is considered much too low for a speculative investment of this type.

The foregoing discussion would indicate the nature of the factors involved in the valuation of a patent on a purely commercial basis. It is, however, well to point out in this connection that the exploitation of patents is now coming more and more to be recognized as a matter of national concern. A considerable volume of research in the country is financed out of public funds and the large and increasing number of patents arising out of such research has brought forward the question of setting up a public institution or organization which would be invested with the patent rights and which

would also take over privately owned patents voluntarily dedicated to it and arrange for their exploitation in the best interest of the country without being guided solely by consideration of monopoly profits. Considerations of national interest might link up the question of the exploitation of patents with, and make it an integral part of, a plan of industrial development and, should such a plan demand it, the licence for use of patents may in particular cases be granted to several parties for commercial exploitation on a regional basis, not so much for earning profits as for rectifying uneven distribution of industries in the country; in some cases the use of patented processes may have to be made even generally available, free of any claim for royalties, according to such a plan.

REPORT OF THE INDUSTRIALISTS' MISSION SCIENTIFIC RESEARCH AND INDUSTRIAL DEVELOPMENT

THE Indian industrialists, who returned to India early this month after a successful tour in the U.S.A. and U.K. covering nearly four months, have issued a report on their visit. The Mission created much interest in both the countries and the members were accorded every possible facility for travelling and discussion. They have returned from their trip "enriched with firsthand knowledge of the economic and industrial conditions and prospects in Great Britain and the United States of America and with a better informed appreciation of the significance, scope, needs and complexities of modern industry. We have come back more than ever convinced that only by means of large-scale industrialization, backed by massive scientific research and education, can India hope to emerge from her poverty and distress and rapidly build up the high standard of living to which her people are entitled and so desperately aspire."

Referring to the scientific research in relation to industrial efficiency and advancement, the report says: "We were much impressed by the improvements in technique and the scientific advances effected in both countries in recent years and by the indications of the further rapid progress expected in the future. The immense complexity of modern industry, particularly in the engineering and chemical fields, and the rapid progress made in them from year to year as a result of research, have convinced us that

if India's industrialization is to be as speedy as public opinion and her economic situation demand, we should unhesitatingly seek to import ready-made technique and industrial 'know-how' from these two and other countries. . . . In both the countries applied and theoretic research is being conducted on a gigantic scale and money lavished on it by both Government and private enterprise."

During their tour, the industrialists investigated the possibility of capital equipment becoming available in India in the immediate future. "With the possible exception of medium-sized, general-purpose machine tools, which will be available in both countries fairly freely, the demand for capital equipment both from domestic markets and from the rest of the world is so great that deliveries and prices are bound to be unfavourable for a considerable time. The position is probably the least satisfactory in regard to textile machinery, for which India's need is perhaps the most urgent. There appears to be no chance of getting any for a long time from America, while deliveries from England cannot be expected under two years. In the case of other types of capital equipment such as power plants, heavy and special purpose machine tools, transport equipment, electrical equipment, mining machinery, forging, foundry and chemical plants, etc., delivery periods vary greatly from six months to two years or more, but they are generally longer in England than in the U.S.A."

THE UTILIZATION OF JUTE WASTE

By C. R. NODDER

(Technological Research Laboratories, Indian Central Jute Committee)

THE waste products coming from jute manufactures form only a small percentage of the raw material, if we except the *stick* left when the fibre is stripped from the stems after retting.

Normally, all the low-quality, barky fibre can be used in producing coarse weft yarns for sackings and the waste consists only of very short fibre fragments and pieces of *bark* together with any dust and sand that may be present. This waste often forms less than five per cent. of the raw fibre, and since some five per cent. of mineral oil is added to the fibre in batching, the weight of cloth produced is roughly equal to the weight of raw jute used ; it may even be more.

Jute cuttings are passed through a teaser-card and the waste from this machine together with the waste falling below other cards, looms, etc., is taken to the "dust-shaker." The fibrous material is retained and can be reused for sacking weft mixes. The waste or *dust* rejected by the shaker forms the only real waste. It is often burnt in the boilers.

The dust-shaker waste is too dirty for use in paper manufacture. Its cellulose content is low. There is some possibility that it might find a use in the manufacture of synthetic plastics, though it is doubtful if it could be used without being largely supplemented by other materials, such as the short fibre from the dust-shaker, and by fillers such as wood-flour or jute fibre of reasonable quality and moderate purity. In considering possible uses, it is to be remembered that it may contain five per cent. or more of mineral oil. There may be possibilities of using it, along with other combustible materials, in making briquettes for fuel. This seems to be worth further attention as one of the most promising outlets. Possibilities for the shaker fibre are in the manufacture of needle-felts and tarred roofing-felts and the like.

There are a number of products obtained in jute processing which may be diverted to

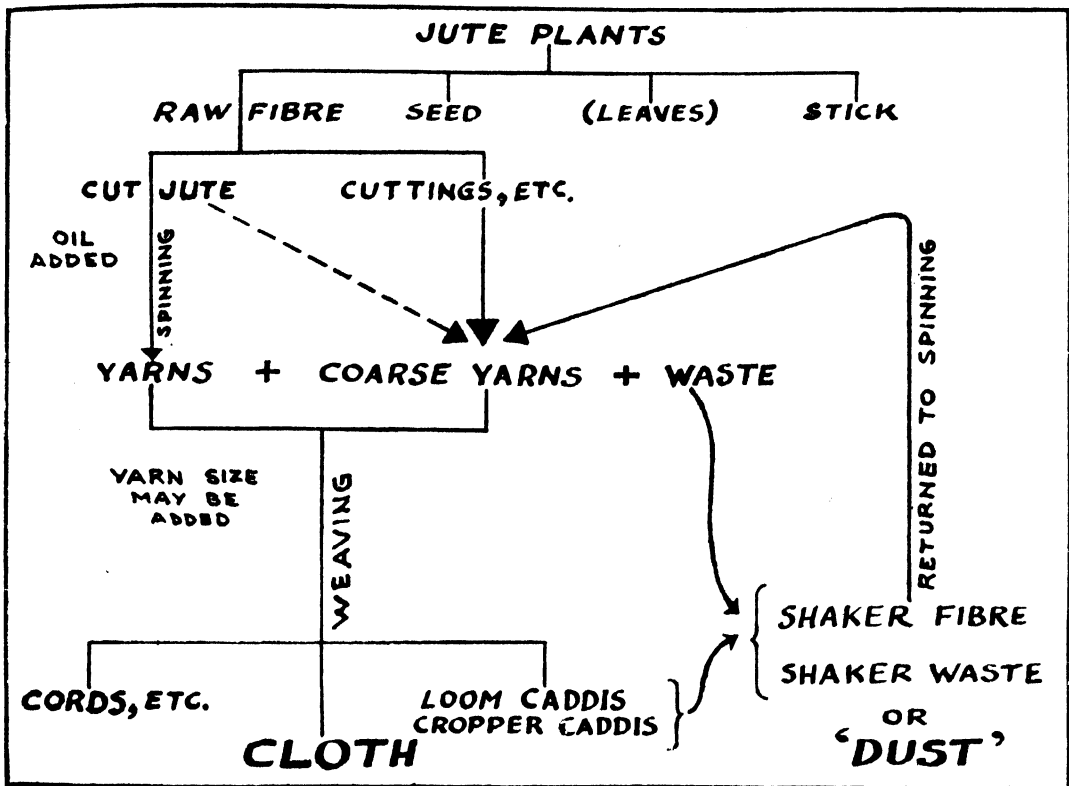
other uses instead of being reused in spinning. These are :—

- (a) cuttings—(stiff, barky fibre cut off from the long jute),
- (b) caddis—(short fibre that falls below cards, drawing frames, looms, cropping machines, etc.), and
- (c) dust-shaker fibre.

Cuttings may be used, along with other raw materials (rags, sabai grass, etc.), in the manufacture of low to medium quality paper, cardboard, etc. Their price, including the cost of transport to the paper mill, is the factor which determines whether or not this is worth while. A certain amount of cuttings has been so used from time to time for a long while. Some forms of caddis, especially hessian-loom and cropper caddis, are of fair purity and could be used for paper of a better quality than that for which cuttings are suitable. Price, at the paper mill, is again the governing factor. Jute fibre is a good insulator for heat and there are possibilities of using caddis as a packing material for such purposes, either loose or compressed. Teased cuttings are cheap and might be similarly used.

Dust-shaker fibre can be used for low quality paper and for making strawboards and insulating boards (for sound and heat) and similar products. It has been found suitable, after disintegration, as a filler in plastic compositions for injection moulding. Jute sticks are suitable for use in the manufacture of brown wrapping paper if used to the extent of about 25 per cent. along with other raw materials. The pulped stick merely acts as a filler. But the stick is bulky and the costs of transport are high. The sticks have well-known rural uses, as in the construction of shelters for betel-vines.

Fibre of very low quality, such as that extracted from jute left in the field until the seeds are ripe, falls along with cuttings as regards possible uses. Jute wax along with mineral oil could be extracted from various forms of waste by means of organic solvents



but it is doubtful if such extraction would be economical. Flax *pouce* contains more wax of a better quality and it has been proposed to extract it and use the product for boot polishes, etc., but apparently there have been no commercial developments.

Jute waste can hardly compete with cotton linters as a raw material for rayon, on account of the high proportion of non-cellulosic impurities.

It may be said that price in relation to that of competitive products, and the costs of transport, are the factors which mainly govern the development of uses of jute by-products. The paper trade is well aware of the possibilities and would no doubt take advantage of any materials offered at a suitable price. Since mills are able to use very low quality fibre for sacking web they are not faced with serious problems in the disposal of waste and no revolutionary deve-

lopments can be visualised by the disposal of shaker waste. Nevertheless, the *Indian Central Jute Committee* is continually seeking possible outlets for shaker-waste and for the diversion of the by-products of higher quality. It may also be said that the trade has the problem of reducing and utilizing waste well in mind and would not be slow to follow up promising proposals. A number of possible uses that have been mentioned have been suggested by Mr. A. S. Gillies, Manager, who has had long experience of jute mill problems. Two Nissen huts have been heat-insulated by packing teased cuttings between two roof layers and the effect is about equivalent to external thatching with paddy straw. Prof. B. C. Guha has had considerable success in the utilization of shaker-waste and shaker-fibre for the production of a thermosetting plastic (Jutelite) and the process has been covered by a patent.

Semi-micro Quantitative Organic Analysis.

By E. P. CLARK (Academic Press, Inc., New York), 1943. Pp. v+135. Price \$2.50.

THIS excellent monograph deals with analytical methods on samples ranging from 10 to 25 mg. for the determination of the following: (a) carbon and hydrogen, (b) nitrogen, (c) halogens, (d) sulphur, (e) phosphorus, (f) methoxyl and ethoxyl groups, (g) acetyl groups, (h) molecular weights, (i) volatile fatty acids.

The essential feature of this book is the exhaustive presentation of semi-micro analytical methods which have been well tested by the author himself, and which he feels can be followed successfully by workers in the same field. These methods were published as a series of papers in the *Journal of the Official Association of Agricultural Chemists*, and they closely follow, in manipulation and procedure, the classical methods of Pregl. Among the relatively newer methods described in the book, and worthy of special note, are the ethanalamine-sodium method of Rauscher for the estimation of halogens—a very much simpler but less known method than the classical one of Carius—a rapid volumetric method for the determination of methoxyl and ethoxyl groups, and the Signer method, employing the principle of iso-thermal distillation, for the determination of molecular weights.

This volume meets a long-felt need and should prove invaluable to research and analytical laboratories as it gives precise details of procedure with suitable diagrams of analytical methods which are not so exacting in technique and laboratory conditions as the well-known micro methods.

H. R. NANJI.

You and Your Radio. By V. V. L. RAO (Addison & Co., Ltd., Madras), 2nd revised edition, 1945. Pp. xvi+170. Price Rs. 5.

The cultural and educational potentialities of broadcasting are being increasingly recognized all over the world, and it is very

encouraging to find that during the past few years, increasing attention is being paid in India to the development of broadcasting. The public is also taking a keen interest in these developments and is getting more and more "radio-minded." There has been a demand for publications dealing with the technical aspects of broadcasting and Mr. Rao has set himself the task of satisfying a widely felt want.

Mr. Rao has chosen for his book the title "You and Your Radio." He points out that he chose this title because "it will provide you with enough material to obtain unalloyed entertainment and education from your radio; it can be very aptly given the sub-title 'All About Broadcasting.' It tells you really A to Z about Broadcasting." Even a cursory glance at the book will show that Mr. Rao has touched upon almost all the aspects of broadcasting, and his treatment is more or less of the dictionary type. Mr. Rao claims that by reading the book one can learn "how to buy a good radio and repair it when it fails."

At some places the author has made general statements which are somewhat misleading; as instances the statements on the number of valves in a set (p. 24), and on the ideal aerial (p. 30) may be cited. His views on ether "as an invisible fluid medium, essential for the propagation of wireless and other electro-magnetic waves" (p. 27) are out of date. His statement about the splitting of ionised layers into two distinct layers after sunset (p. 71) is far from true. Mr. Rao's description of power supply shows that the book is probably meant for the South Indian Provinces.

The book serves a useful purpose. It puts before the layman, in simple language, the various technical words, symbols and descriptions of many radio and gramophone components. It also contains useful information on broadcasting in India. The book should be useful to those who wish to be initiated into the art of broadcasting.

G. R. TOSHNIWAL.

METALLURGICAL RESEARCH WORK OF THE INDIAN RAILWAY BOARD

THE Railway Board has been having a Research Organization of their own for a number of years for dealing with Mechanical Engineering and Civil Engineering problems. When the Department of Scientific and Industrial Research was organized, the Railway Board also took an initiative in starting a Metallurgical Research Section as a part of their existing Research Department under the Chief Controller of Standardization.

The first set of these Research problems was entrusted to Dr. D. R. Malhotra, Chairman, Railway Chief Metallurgists' Committee, and the work was conducted at the Ajmer Laboratory with the funds provided by the Railway Board.

A brief description of these researches is given below.

Conservation of Non-ferrous Metals

This report written by Dr. Malhotra has been published by the Railway Board. The investigations have been divided into the following sections:—

1. Pickling and Tinning.
2. White Metalling procedure under varying conditions pertaining to Pouring Temperature, Temperature of the Bearing Metal and the Chill.
3. Determination of Bond Strength, Brinell Hardness and Microscopic Examination.
4. Physical properties of white metals at room and elevated temperatures.
5. Determination of suitable casting conditions from the thermal relationships existing between the white metal and the shell temperatures.
6. Recommendations regarding suitable technique for the guidance of the Railways using war emergency white metals.

The investigation clearly points out that in an antifriction metal complying with the following war emergency specification, Tin=19-21 per cent., Antimony=14-16 per

cent., Copper=1.25-1.75 per cent., Lead=remainder, copper is not associated with antimony to form purple Cu_2Sb as happens in the case of low tin antifriction metals (Tin about 5 per cent.) but is associated with tin in the form of Cu_3Sn as is the case of high tin alloys (Tin 60 per cent.). Another series of experiments conducted to determine the pounding and crushing properties of these bearing metals showed that in the case of 20 per cent. tin white metals, the fall in strength was only from 10,020 lbs. to 7,940 lbs. per sq. inch with temperatures varying from 30° C. to 150° C. This is in very close agreement with white metals containing 80 per cent. tin. Therefore, as a result of these experiments, the new war emergency specification has been proved to be capable of replacing high tin bearing antifriction alloys without having any adverse effect on their bearing properties. This investigation will prove of very great value to Indian Railways so far as conservation of tin is concerned.

Dephosphorization of Steel Castings

Before the war, hæmatite pig iron was imported from England for the manufacture of steel castings in the Ajmer Workshop. The extensive demand for this material in England for the production of acid steel for war purposes, and its consequent shortage, coupled with abnormal shipping difficulties, led to the stoppage of Indian imports of hæmatite pig iron, and the Tropenas steel plant at Ajmer had to be operated either by melting good quality scrap or by reducing the phosphorus content in the Indian pig irons. Since the quantity of good quality scrap was limited, it was found essential to develop a process for dephosphorizing the metal and thereby promoting the use of indigenous pig iron to replace the imported hæmatite pig iron. For this purpose the Perrin process of dephosphorization as developed at *Tatas* was studied. In the Perrin process molten pig iron containing about 0.3 per cent. phosphorus is blown in an acid converter and the resultant blown metal is rapidly dephosphorized by pouring it from a height of 21' into a basic oxidizing synthetic molten slag manufactured in an electric furnace.

In the Ajmer steel plant there was neither an electric furnace to melt the desired slag, nor were any facilities available for pouring the metal from any height.

Therefore, all the experiments were carried out by mixing the blown metal having a high phosphorus content with about 5 per cent. of the cold dephosphorizing mixture consisting of burnt lime, iron ore, mill scale, flux (ilmenite, soda ash, calcium fluoride), etc. The results have been very encouraging and it has been possible to reduce the phosphorus content from 0.092 to 0.056 per cent. and from 0.056 to 0.02 per cent.

This investigation has clearly shown that:—

- (1) The quality of limestone plays a very important part in the reduction of phosphorus. To be effective, limestone should be practically free from silica and iron.
- (2) The height of pouring plays an important part but we have not been able to determine the optimum height to get the best results.

The work is still in progress and further results are awaited.

High Duty Cast Iron

Railway workshops in India manufacture a very large quantity of cast iron castings for their own use in railway rolling stock. The type of furnaces employed and the nature of the metallic charge used in these furnaces vary practically in each case.

Generally speaking, the melting rate in a cupola furnace is calculated from the following formula:—

$$\text{Melting rate (tons per hour)} = \frac{\text{Fuel burning rate} \times \text{fuel ratio} \times \frac{1}{4} \sqrt{P}}{2000}$$

where P is the pressure in the wind box. The fuel ratio is the ratio of coke to iron, and normally speaking 10 of iron and 1 of coke

is considered good practice. The fuel burning ratio can be taken from the following table:—

Cupola dia. Inches		Coke per hour lbs.
24	.. ..	450
30	.. ..	700
36	.. ..	1,000
42	.. ..	1,400
48	.. ..	1,800
54	.. ..	2,300
60	.. ..	2,800
66	.. ..	3,400
72	.. ..	4,000

In most of the cases, the melting rate is not properly worked out, with the result that the metal is sluggish or overoxidized and not suitable for castings.

The experiments have shown quite conclusively that high grade cast iron, similar to *Meehanite*—a patented material, can be manufactured by observing the following procedure:—

- (1) By improving furnace technique, i.e.,
 - (a) increase of coke bed with corresponding increase in air volume. One ton of air per ton of metal has been found to be most satisfactory. This would result in improved melting rate and thereby would lower the absorption of carbon from the fuel.
- (2) By incorporating steel scrap in the charge. This was done with a view to reduce the carbon and phosphorus contents in the metal.
- (3) By inoculation. The metal from the cupola complying with the following chemical composition, total carbon = 2.5—3.0 per cent., silicon = < 2 per cent., was inoculated with powdered electro-silicon. The addition tends to throw down graphitic carbon in fine particles which are uniformly dispersed throughout the mass of the metal.

By this process it has been found possible to produce successfully Grade II cast iron to *B.S.S. No. 786—1938*, which is a definite improvement on the old practice followed on the Indian Railways.

A detailed report on the research work has been published in *I.R.C.A. Proceedings*, 1943, 1944 and 1945.

INDUSTRIAL RESEARCH PLANNING

REPORT OF THE I. R. P. C.

THE Industrial Research Planning Committee appointed by the *Council of Scientific and Industrial Research* in 1944, to make a comprehensive survey of the existing facilities for scientific and industrial research in India, and to report on necessary measures of co-ordination, control, direction and development of such research by various agencies, and on other steps necessary for the planning of such research in post-war India, has issued a comprehensive report.

The report points out that the present research activity in India does not represent even the bare minimum whether judged by international standards or the actual requirements of the country in her present state of industrial development. The need for research is felt not only for facilitating an adjustment to post-war conditions but also for promoting the general cause of industrialization at a time which will be rendered much more difficult by the forces of international competition. The capacity of Indian industry to withstand international competition will depend materially on its vision and readiness to implement the latest results of research in a continual effort for improving its productive efficiency by economy in the use of raw materials, utilization of by-products, reduced power cost and so on. Research will also play a decisive part in the development of new industries for which opportunities remain imperfectly explored.

Industrial research in India is still in its infancy. Besides the lack of an effective link between our principal research institutions and the industrial interests concerned, a further obstacle to the creation of a suitable research atmosphere is that while industry constitutes a Provincial subject, it is beyond the resources of most of the Provinces to build up adequate research organizations for serving the needs of local industries. The institutes set up by the Government of India have remained much too centralised for meeting the various regional needs. Moreover, industry, with some rare exceptions, has not become research-minded. Nor is there any effective liaison between industry and research organizations. There is also lack of inter-departmental co-ordination. Programmes of researches of various institutes concerned with industrial research

are not framed by mutual consultation or according to any co-ordinated plan.

Recommendations

If scientific and industrial research is to make any headway in India in the immediate future, the Government must take the initiative in setting up a suitable machinery for the development of research along sound lines, strengthen the science departments of universities and existing research institutions and bring about an effective co-ordination amongst all the institutions. For stimulating and directing scientific and industrial research on a planned and comprehensive basis, the Committee recommends that the Government of India should forthwith set up a central research organization to be called the National Research Council. The Council, which should be an autonomous body, should have a total membership of 60 made up of 20 scientists elected by the universities and recognized scientific associations, 15 members elected by recognized chambers of commerce and associations of manufacturers, five members elected by recognized trade unions and other labour organizations, and 20 members nominated by the Government of India of whom not more than 8 may be official. Of these two should represent the railway administration.

The functions of the Council will be as follows:

- (i) To organize and maintain national laboratories.
- (ii) To establish and maintain specialized research institutes.
- (iii) To stimulate pure and applied research in universities by grants-in-aid and by the institution of scholarships and fellowships.
- (iv) To provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad.
- (v) To stimulate and encourage research activities by industry.
- (vi) To co-ordinate research activities of all the existing research institutes and departments of Government and undertake planning of research programmes on a comprehensive basis.
- (vii) To function as a National Trust for Patents.

(viii) To set up a Board of Standards and Specifications.

(ix) To function as a clearing house of scientific and technical intelligence, to encourage deserving scientific and technical societies and to foster the growth of new ones on appropriate lines.

A small executive body, to be called the Research Board, will be responsible for the administration of the work of the Council.

Specialized Institutes

The establishment of a National Chemical and a National Physical Laboratory is recommended at an estimated cost of Rs. 40 lakhs each. It is further recommended that in the absence of industrial research associations in India (except for jute and tea), it is necessary for the State to take the initiative for the establishment of a number of specialized laboratories for fulfilling the object. Nine new specialized institutes are recommended with an indication of the order of priority as follows:—Institute of Food Technology; Metallurgical Institute; Fuel Research Institute; Glass and Silicate Research Institute; Oils and Paints Institute; Buildings and Road Institute; Leather and Tanning Institute; Industrial Fermentation Institute and Electro-Chemical Institute.

Grants to Universities

The Committee considers that universities constitute the foundation of all research and suggests the strengthening of scientific teaching and research work in Indian universities. As an essential part of the five-year plan, the Committee recommends that the National Research Council should make substantial grants for strengthening the scientific departments of the universities. For this purpose the Grants Committee should make a survey of science and research departments of all the Indian universities and recommend to the National Council a scheme of financial assistance to the latter. Out of the bulk grant of Rs. 6 crores, a sum of about Rs. 2 crores should be set aside for giving grants-in-aid to the 19 universities. Further, adequate engineering research sections should be built up and maintained in all the engineering colleges. Teachers in such colleges should be in contact with engineering industries.

To man the various laboratories proposed to be set up and to keep alive the research work in the country the Committee recommends that 700 research workers should be trained in five years involving an estimated total expenditure of about Rs. 50 lakhs:

Rs. 27 lakhs for foreign scholarships and Rs. 23 lakhs for Indian scholarships. Industries should be encouraged to set up their own research associations on a corporate basis by exemption of research expenditure of firms from income-tax assessment.

A network of corresponding research organizations should be set up in Provinces and major States. It is recommended that research councils on the model of the National Research Council composed of scientists, representatives of industry and administration, should be set up in all the Provinces and major States.

National Trust of Patents

A suitable method for the exploitation of patents in respect of inventions made by either the national laboratories or universities and other research organizations should be evolved. A National Trust of Patents should be set up for the purpose of holding and exploiting all patents resulting from research financed by Government and those dedicated by individual scientists and by institutions, supported either by public funds or private endowments.

The setting up of a Board of Standards for drawing up Indian Standard Specifications and the establishment of a technological institute on the lines of the Massachusetts Institute of Technology are recommended.

The Committee emphasizes that research can yield its best results only when it is backed by a comprehensive industrial plan. This will not only inspire enthusiasm among research workers but will serve the practical purpose of indicating the order of priority in the various lines of investigation. The Committee accordingly recommends that the National Research Council must work in close co-operation with the department of industrial planning so that industry and research will each stimulate the other.

The Committee further emphasizes the organic relationship between the different categories of research, viz., agricultural, medical and industrial, and welcomes the constitution of the Scientific Consultative Committee in the Department of Planning and Development, as a body expected to secure the necessary co-ordination at a high level. The Committee, however, considers it necessary to examine the possibility of bringing all the research activities of the various Government Departments under the administrative control of the Member for Planning and Development.

Obituary

DR. H. K. SEN, M.A., D.Sc., P.R.S., D.I.C., F.N.I.



DR. H. K. SEN

THE premature death of Dr. H. K. Sen on 3rd June will be felt not only as a loss to science in India, but as a personal grief to many of his pupils, friends and admirers. An eminent chemist, with a wide industrial outlook, Dr. Sen made a special study of many of the present-day industrial problems. His death at a critical juncture, when India is about to enter into a new phase of industrial expansion and needs the accumulated experience of her scientists more than ever before, is an irreparable loss.

Born in 1888 in a middle-class family of East Bengal, Dr. Sen had his schooling in Brahmanbaria (Tipperah) and college education at Calcutta. He had a brilliant academic career and obtained in 1911 a first class M.A. Degree from the Presidency College, Calcutta. He joined the City College, Calcutta, in 1912 as Professor of Chemistry, but the inspiring personality of his teacher, Sir P. C. Ray, attracted him to the Presidency College where he devoted all his spare time

to research. From the great savant he imbibed, in a large measure, his undying love for research and a keen national outlook. A Calcutta University Scholarship (Premchand Roychand Studentship) enabled him in 1912 to proceed to England where he worked in the laboratories of Sir Jocelyn Thorpe. An original contribution on "The condensation of β -diketones with Cyanacetamide" brought him the Doctorate in Science (1915). While in London he made a name for himself by developing, as a war-time exigency, a process for making β -eucaine which was later exploited by *Messrs. Boots & Co., Ltd.*

Back in India his successive associations with the firms of *Messrs. Tata Iron and Steel Co., Jamal Bros. & Co., De Souza and Rangoon Chemical and Pharmaceutical Works* gave him firsthand experience of manufacturing firms and made him realize the importance and urgency of applied researches in an industrially backward country like India. When the Chair of the newly created Ghosh Professor of Applied Chemistry was offered to him by Sir Asutosh Mukherjee in 1920, he did not hesitate to accept it.

As a University Professor, he went deep into the problem of cheap power supply as a prerequisite to industrial development and initiated, *inter alia*, a line of work on the utilization of water hyacinth—the scourge of Bengal—and saw-dust as sources of power alcohol. Between 1920 and 1930 he twice visited England and Germany to gain firsthand knowledge of fuel technology and associated subjects. In 1933, he attended the World Power Conference in Berlin as a delegate from India.

Dr. Sen's most important work at the University related to the designing and perfection of a low-temperature coal carbonization plant, which though functioning well in several centres has its potentialities still largely unexplored. His profound knowledge of fuel technology and practical interest in synthetic fertilizers led to his election as Chairman of the Fuel Research Committee. In 1944 he joined the Bihar Government as Director of Industries, primarily with a view

to enable that Government to develop post-war industries. It is a pity that while his characteristic drive and continued exertion, in utter disregard of his health and personal comfort, have served to secure for Bihar the foundation of low-temperature carbonization and fertilizer industries, excessive strain and overwork for a cause so dear to his heart brought about his sudden prostration and premature end.

But the most fruitful period in Dr. Sen's life, to judge by its immediate results, commenced with his appointment as Director, Indian Lac Research Institute (Namkum) in 1936. Established in 1925, mainly for biochemical, physico-chemical and entomological researches on lac, the activities of the Institute had remained rather obscure. With the arrival of Dr. Sen, special stress was laid on the industrial uses of lac and the Institute underwent rapid expansion in all directions. The research programme was revised and a period of fruitful collaboration between himself and his associates ensued, leading to important findings. On the industrial side moulding

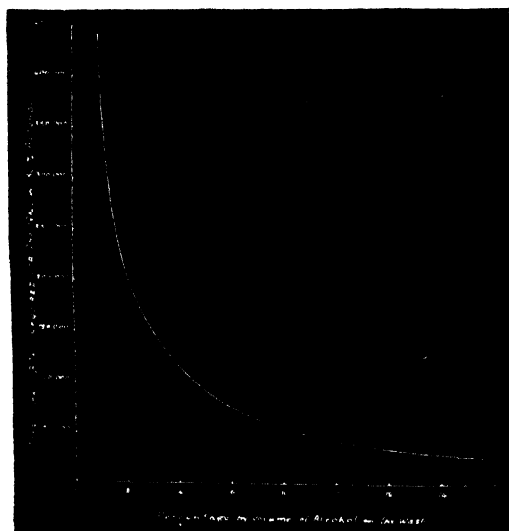
compositions, varnishes, adhesives, etc., were formulated and the applications of lac in the preparation of many useful items were indicated. In the purely scientific side, the analytical methods of lac were modified and developed and the electrical and physico-chemical properties of lac were studied. In fact, he gave a new orientation to the research activities of the Institute.

Dr. Sen was one of the foremost scientists of India and had an honoured place in many seats of learning and research organizations. He was a member of the Plastics Committee of the *Board of Scientific and Industrial Research*, Chairman of the Fuel Research, Heavy Chemicals and Industries Committees, a foundation fellow of the National Institute of Sciences, President of the Indian Chemical Society and of the Institution of Chemists (India).

He will be remembered with affection by all who knew him, and particularly by those for whom and with whom he worked at the *Lac Research Institute*.

P. K. BOSE

ADVANCES IN DISTILLERY PRACTICE—Part I



Approximate B.Th.U. required for production of One Gallon 80 per cent. Alcohol from Wash of Different Strengths.

THE percentage of alcohol, which obtains at the moment in distillery washes in India varies between 6 and 8 per cent ; 7 per cent. is the average ; percentages as low as 5 are not uncommon.

The problem of raising the percentage to 12 (American and Continental practice records 14 to 16 per cent.) has now been successfully solved in the Section of Fermentation Technology, Indian Institute of Science.

The curve alongside gives an idea of the fuel economy secured by this process.

The process as developed does not involve any material alterations in the distillery plant or practice.

THE NATIONAL COLLECTION OF TYPE CULTURES, INDIA

SECTION OF FERMENTATION TECHNOLOGY

INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE NATIONAL CHEMICAL LABORATORY

PROPOSED PLAN*

INDIA needs the organization of scientific and technical research on an extensive scale for her industrial development. In recognition of this need, it is proposed to establish a National Chemical Laboratory in India. A tentative scheme for the laboratory was drawn up in 1943 and circulated to a large number of scientific organizations and individuals in this country and abroad. The present plan has been formulated after a careful consideration of the suggestions received, the lines along which similar laboratories in other countries have been established, and the special needs of India. This plan, therefore, is based upon the views and recommendations of a large number of leading scientists and scientific organizations.

The laboratory will concern itself with developing the means for the application of scientific knowledge to practical problems of human welfare and its work will be largely of fundamental, basic and applied nature, on lines likely to promote research in industrial chemistry and the chemical utilization of the raw material resources so as to help the development of the country and its industries.

The work of the National Chemical Laboratory will be divided into seven main divisions :—

1. Division of Inorganic Chemistry including Analytical Chemistry.
2. Division of Physical Chemistry including Electro-chemistry.
3. Division of the Chemistry of High Polymers.
4. Division of Organic Chemistry.
5. Division of Biochemistry including Biological Evaluation.
6. Division of Chemical Engineering.
7. Division of Survey and Intelligence.

The scope of work of each division has been briefly indicated in the body of the report.

Poona, which enjoys a moderate climate all the year round, and is within easy reach of Bombay and her industries, has been selected for the location of the laboratory. A site of 430 acres on a beautiful, breezy and healthy plateau, and in close proximity to educational institutions of the town, has been selected for the laboratory on the Pashan Road.

The staff requirement of the laboratory has been carefully worked out by the Committee for various divisions and activities. This is summarized below :—

1. Scientific staff.
 - (a) Director, Heads of Divisions, Senior Research Officers and Research Officers 51
 - (b) Research Assistants 64
2. Administration and ministerial staff 42
3. Technical staff for workshop and various services 35
4. Stores, Laboratory Assistants and Attendants 86
5. Inferior staff 42

Total .. 320

The floor space requirements of buildings to house the different activities of the laboratory have also been carefully worked out by the Committee. These are summarized below :—

	Sq. ft.
1. Main building, housing various Divisions	150,000
2. 10 Auxiliary buildings	30,000
Total	180,000

The detailed plan of the buildings will be drawn up by competent and qualified architects.

The question of residences has also been considered, and it is proposed that 119 residences, with a total floor space of 200,000 sq. ft. accommodating 168 persons, may be built by taking an interest-free loan from the Government of India to be liquidated by rent payments in 25 to 30 years.

The financial implications of the scheme are summarized below :—

<i>Non-recurring expenditure—</i>		Rs.
Cost of land .. .. .	.. .. .	2,50,000
Cost of main building .. .. .	.. .. .	15,00,000
Cost of auxiliary buildings .. .. .	.. .. .	1,50,000
Cost of general equipment, chemicals, apparatus and books .. .. .	.. .. .	12,00,000
Cost of equipping the buildings .. .. .	.. .. .	2,50,000
Total	Rs.	33,50,000

Recurring expenditure during the first year—

	Rs.
Salaries of scientific staff	4,48,800
Salaries of technical staff	1,98,720
Scholarships	30,000
Contingencies, workshop, library, apparatus, chemicals and maintenance	2,75,000
Total	Rs. 9,52,520

After the first year, there will be an annual increase of Rs. 50,676 in the recurring expenditure due to annual increments in the salaries of the staff.

A total sum of Rs. 38,90,000 in the form of cash and equipment is expected to be available for the laboratory as detailed below :—

	Rs.
Donation from the Tata Organization	8,30,000
Allocation from the grant of the Government of India for the development of National Laboratories	25,00,000
Value of equipment, chemicals, apparatus, and library of the existing Chemical Laboratory of the Council of Scientific and Industrial Research	5,60,000
Total	Rs. 38,90,000

* This is a summary of the plan which has now been finalized by the Planning Committee of the National Chemical Laboratory. Copies of the detailed plan are available for scientists and can be obtained by writing to the Secretary, Planning Committee (N.C.L.), c/o Council of Scientific and Industrial Research, Imperial Secretariat, North Block, New Delhi. Suggestions and criticisms will be welcomed.

Reports from States and Provinces

Jaipur

Five-year Industrial Plan

JAIPUR has within her borders such valuable minerals as copper, lead, beryl, mica, glass-sand, china-clay, soapstone, lime-stone, felspar, calcite, magnesite, red and yellow ochres, barytes, etc. Sheep-rearing is an important occupation in the sandy regions of Rajputana, yielding approximately 99,500 lbs. of wool per annum, while over 3 lakhs of maunds of *til*, mustard, groundnut, linseed, castor and other oilseeds are grown in the more fertile tracts of Sawai-Madhopur and Malpura Districts. More than 11,000 maunds of raw hides and 8,000 maunds of skins are exported every year from the *Khalsa* areas to the neighbouring Provinces, together with 21,000 maunds of bones. That sufficient private enterprise and capital are forthcoming is evident from the fact that as many as 107 joint-stock companies, with an aggregate authorized capital of Rs. 19½ crores, have been floated within the State since the passing of the *Jaipur Companies Act* in 1942. But the absence of large rivers, which could be harnessed for generating power, and forests, which would yield firewood as a substitute for coal, has been the main obstacle in the way of industrial development.

With a view to develop the vast potential resources of the State, the Government of Jaipur launched a policy of industrialization in 1943. There are to-day over 130 industrial establishments in the State, involving a capital investment of Rs. 1,58,00,000 and employing a labour force of 28,000 persons, besides 185 flour mills. The six large-scale factories, each with a subscribed capital of over Rs. 5 lakhs, are engaged in the manufacture of non-ferrous alloys (brass, copper, gun-metal, phosphor bronze, arsenical copper, leaded brass, naval brass, etc.), maize starch, hollow glassware and tents, fabrication of iron and steel articles required by the Defence Services, and the pulverizing of talc. Among the medium and small-scale industries, the more important are engineering workshops, printing presses, salt refinery, wire drawing, oilseed crushing, lapidary work and the manufacture of agricultural implements, gas plants, saltpetre, oilcloth and waterproof products, carpets, blankets, felts, tweeds, hosiery and cotton fabrics on handlooms, confectionery, soaps, hair oils, tooth paste, ink and Ayurvedic medicines.

Besides these, the starting of numerous other factories is on the programme. Chief among them are one cotton mill, one woollen mill, three glass and pottery works, 12 oil mills, one tannery, one rubber factory, one brass rolling mill, one bone-crushing mill, and factories for the manufacture of heavy and fine chemicals, pharmaceuticals, cement pipes and R.C. poles, tools, and implements, lanterns, cycle component parts, stoneware, tiles and refractory bricks, vegetable ghee, soap and leather goods. The management of the *Kamani* group of industries have launched a project for the manufacture of alkalis out of the bitters of the Sambhar Salt Lake.

In the field of small and medium-sized industries, power-loom weaving, retreading of motor car tyres

and the manufacture of agricultural implements, cutlery and scientific instruments, buckets and hollow-ware, electric bulbs, rubber goods, lead pencils, paints, sandpaper and abrasives are under contemplation.

There is also sufficient scope for the starting of housebuilding and film producing companies within the State. Separate industrial areas for large and small-scale factories are being formed both in Jaipur City and Sawai-Madhopur, while negotiations for acquiring sites for the construction of a bullion market, a Stock Exchange and a permanent exhibition building are under way. The Jaipur Chamber of Commerce is expected to expand its activities and have its own building for a library and a commercial museum.

As no facilities exist at present for technical training in the State, and as a continuous flow of trained technical personnel is an essential prerequisite for industrial development, it is proposed to open a technological institute at Jaipur with diploma courses in mechanical, electrical, automobile and radio engineering, a civil engineering school for overseers and classes for compositors and pressmen in the Government Printing Press. The Government also propose to award a number of scholarships in technical subjects to deserving candidates.

Jaipur has long been famous for its numerous handicrafts. The genius of the local artisan flows out in the delightful *tie and dye* printed fabrics, carpets, felts, engraved and embossed brassware, silverware, ivory and stone carving, marble statue and images, jewellery, papier-mache toys, etc. Paper making by hand is an important rural industry of Sanganer and Sawai-Madhopur. Hence a special and important place has been accorded to cottage industries in the plan. Besides a central polytechnic or cottage industries institute, district industrial schools, peripatetic demonstration parties for introducing labour-saving appliances and training the artisans in improved methods of technique of hand weaving of cotton and wool, dyeing and calico printing, eri culture, blacksmithy, tanning and charcoal making, and an experimental sheep-breeding farm, there will be a central marketing organization which would popularize the products of Jaipur art-crafts both in Indian and in foreign markets, by standardizing them, introducing modern designs, establishing agencies and sales depots and issuing catalogues, advertisements, price lists, etc.

Industries likely to be started by private parties during 1945-50.

	Capital Rs.
1. Cotton Mill at Jaipur	25,00,000
2. Two Woollen Mills at Jaipur and Fatehpur	20,00,000
3. Two Glass and Potteries Works at Sawai-Madhopur	15,00,000
4. Five Glass Factories at Jaipur	15,00,000
5. Two Ice Factories	5,00,000
6. Oil Mills at Hindaun, Gangapur, Sawai-Madhopur, Neem-ka-Thana, Khiror, Bagar and Jaipur, etc. ..	25,00,000

	Capital Rs.
7. Chemical and Pharmaceutical Works	50,00,000
8. Cement Pipes Factory	5,00,000
9. Third Cinema at Jaipur	5,00,000
10. Tools and Implements Factory by Messrs. Man Industrial Corporation Ltd.	50,00,000
11. Lanterns, cycle parts, etc., by Jaipur Construction and Engineering Works Ltd.	25,00,000
12. Brass Sheets Rolling Mills	5,00,000
13. Film Production by Messrs. Sunshine Sound Ltd.	5,00,000
14. Film Production by Messrs. Rajasthan Theatres Ltd.	5,00,000
15. Three Vegetable Ghee Factories	15,00,000
16. Chemicals Factory at Sambhar	1,00,00,000
17. Manufacture of Electric bulbs	6,00,000
18. Cement Factory	50,00,000
19. Stoneware Factory	10,00,000
20. Building Companies	50,00,000
21. Tannery	5,00,000
22. Rubber Factory	15,00,000
23. Rubber Tyres Retreading Factory	5,00,000
24. Two Bone Crushing Factories	2,00,000
25. Other small factories	50,00,000
Total	Rs. 5,63,00,000

Mysore

Board of Scientific and Industrial Research

A list of industrial researches and investigations engaging the attention of industrial concerns, laboratories and other institutions in the State for the year 1944-45, has recently been issued. The programme comprises the following :—

Government Sandalwood Oil Factory (Mysore) : Recovery of oil contained in the sandalwood powder by digestion of powder in the cold with petrol of B.P. 70-80° C. and subsequent distillation of the extracted oil with steam.

Government Lac and Paint Works (Mysore) : Standardization of large-scale manufacture of distempers, oil varnishes, varnish paints, etc.

Government Central Industrial Workshop (Bangalore) : Manufacture of Diaphragm pumps, laboratory equipment, special brass turning lathe, envelope cutting dies, hand beaters, paper cutting machine, digester and screw press.

Department of Industries and Commerce : Double lift handloom dobby of 8 shafts ; improvement on fly-shuttle loom to increase production ; improvement of Benares saree weaving with attachment of sewel shuttles ; experiments of Jacquard machine from 100 to 200 hooks ; fur-weaving, erection of raising machine.

Department of Sericulture : Field experiments on refrigeration of eggs to delay hatching, preservation of male moths, etc ; statistical data regarding the yield of mulberry from bush, topes, grafts and study of the behaviour of foreign races ; cross breeds of Chinese and Japanese races with Mysore races ; new methods of determining renditta ; rearing of Chinese races.

Mysore Government Iron and Steel Works (Bhadravati) : Manufacture of resistance alloys (scheme transferred from Council of Scientific and Industrial Research) ; plastics from coffee beans ; dyes from saw dust ; vegetable dyes from bark of woods ; investigations regarding acetic acid, sodium acetate,

calcium carbide, furfural ; nichrome wires.

Government Geological Department (Geological and Chemical Laboratories) : Utilization of limestone as a corrective for excess acidity in the humus-rich soils in coffee plantations ; preparation, on a pilot plant scale, of carborundum, alundum and artificial emery from several raw materials round about Jog (work to be taken up in co-operation with Dr. B. K. Ram Prasad) ; geophysical survey for ascertaining the extent of the graphite deposits near Channanahalli, Mysore District ; underground water resources in selected portions of the State ; survey and prospecting of minerals and their industrial applications.

Government Porcelain Factory (Bangalore) : Manufacture of sanitary ware and domestic crockery ; porcelain portion of the automobile and aeroplane sparking plugs.

Government Silk Weaving Factory (Mysore) : Utilization of lac dye.

Government Electric Factory (Bangalore) : Bakelite moulding, motorization of Bakelite presses, production of electric rotary machinery, electrical accessories and instruments.

Government Industrial and Testing Laboratory (Bangalore) : Creosote B.P. ; caffeine from cherry husk, ragi malt extract, kurchi bismuth iodide, sulphadrag, calcium gluconate.

Government Soap Factory (Bangalore) : Preparation of geraniol from citronella oil ; distillation of aromatic plants.

Engineering College (Bangalore) : Suitability of groundnut, honge and castor oils when mixed with graphite as lubricants for bearings under varying loads ; Cracking of alcohol for generating gas.

Government Dichromate Factory (Belagula) : Manufacture of Potassium permanganate, chromalum, chlorochromate, and chromil-chloride ; manufacture of soda silicate ; glue manufacture from bone-meal effluent.

Mysore Chemicals and Fertilizers Ltd. (Belagula) : Manufacture of pure chemicals, sulphanilamide, saccharine and copper sulphate from the ore available in the State.

Mysore Chrome Tanning Company Ltd. (Bangalore) : Finishing glaze kids, sheep skins and embossed skins, suede leathers.

Mysore Spun Silk Mills Ltd. (Channapatna) : Cocoons : stifling by steam, hot air against sun drying, difference in reeling qualities colour and strength of final silk ; variations in the percentage of silk content of cocoons from season to season, affecting renditta ; rearing of eri cocoons—possibilities and economic aspects ; variations in the weight of cocoons from the 1st day till the emergence of the moths with reference to season, etc., action of certain cleaning agents for soiled silk hanks and for removing gum spots ; silk dryage experiments.

Engineering and Mineral Industrial Research Laboratory (Bangalore) : Production of asbestos wool, yarn, tape, rope and wick ; various types of fire, acid and water-proof cements and paints ; bases for straight parallel type elements for general electrical industries ; small electrodes for dry cells and welding electrodes ; special foundry sand and graphite mixtures for various types of casting work ; carborundum, allundum of abrasives and magnesium metal in electrical furnaces ; micanite from waste mica ; artificial abrasives in small scale furnaces ; plywood material using hard wood and waste materials using vegetable and synthetic resins ; standards and abrasive testing laboratory ; availability of lithium and copper minerals in various parts of the State ; glue and other adhesives.

NOTES AND NEWS

Mica Splitting

THE problem of a workable means of removing mica films in thicknesses between one and three mils., from commercial mica blocks, has been studied by D. W. Kessler of the *U. S. National Bureau of Standards*. This method is intended to be substituted for the usual hand-splitting. It requires three or four months to train a hand-splitter and the average rate of splitting is between 15 and 20 films per minute.

Various chemicals were tried to determine whether the cementing material holding the sheets together could be dissolved. Several physical means, such as high voltage electricity, heat, sudden release of air pressure in container, flexing, steaming, sudden changes of temperature, etc., were tried. Most of these methods gave no promise whatever, and those that showed some tendency to separate the films produced other effects that were undesirable. Efforts were then started to develop a machine that would remove films one by one.

Two mica-splitting devices have been constructed at the *Bureau*. The first consists of a single suction chuckplate which holds the mica blocks while it slides back and forth on a track. The gauge which starts the split is stationary except for a slight rotation in a vertical plane. When a film is started and bent upwards, it is caught by two claws actuated by suction and pressed on a small drum. As the drum rolls back, the film is stripped and carried to a suction belt which deposits it in a tray at some distance from the machine. This device produces about 30 films per minute, the slow rate being caused mainly by the fact that the operation has to be on the chuck. The method of stripping is also believed to be too severe since the bending of films caused more scales and defective sheets than does hand-splitting.

The second device consists of a disc carrying six chuckplates, a starter gauge similar to the first, two stripper blades and a suction belt for removing the films from the machine. With this device little time is lost in changing blocks, since one chuck is loaded by the operator while another block is being split. When the first block is finished, the operator turns the disc until the chuck comes into position, requiring only about one second for the change. With this device there is very little bending of the films and the results are more satisfactory.—(*Chemical Age*, 1945, 53, 28.)

Amarelo 5—An Improved Cigarette-Tobacco

India is one of the leading tobacco-growing countries in the world and extensively grows cigarette-tobacco which is an important money crop. A high class cigarette tobacco variety should give high acre-yields of cured leaf, possessing a bright lemon yellow colour, a good body, texture, flavour and burning quality and low nicotine content. Top-grade bright leaf fetches a higher premium than the poorer grades. At present *Harrison's Special*, an American variety, is the one that is almost exclusively grown in all the cigarette-tobacco-growing tracts in India. As a result of research work carried out at the *Tobacco Research Substation, Guntur*, of the

Imperial Agricultural Research Institute, New Delhi, a promising cigarette tobacco variety, *Amarelo 5*, has been produced. It is a selection from *Amarelo* which is a little known variety useful for flue curing. In the extensive trials conducted, *Amarelo 5* has been immensely successful both in the experimental areas as well as in the cultivators' fields and has proved superior to *Harrison's Special*. Compared to *Harrison's Special*, it matures earlier, gives higher acre yields of cured leaf of good quality, cures several hours earlier resulting in economy of coal required for the curing process and produces 20 per cent. more of top-grade high-priced leaf. It has proved itself uniformly highly successful in such widely separated places as Hyderabad, Cuttack and Pusa thus showing its high degree of adaptability. It does well even in heavier soils which are considered unsuitable for growing *Harrison's Special*. *Amarelo 5* thus easily secures higher economic returns than *Harrison's Special*. The variety is now ready for release to growers.

Pink Bollworm of Cotton

The pink bollworm, *Platyedra gossypiella* Saunders, is one of the major pests of cotton in all cotton-growing areas of the world. Its original home is considered to be India, where it was first observed in 1842 and from where it was carried to other countries. In the United Provinces, the pink bollworm was first recorded to cause damage to cotton crops in 1904.

The earliest work on the biology and control of the pink bollworm in India was carried out in the United Provinces, in and before 1904 by Mr. J. M. Haymann.

From 1921 to 1939, a large series of investigations were conducted on various aspects of the biology, bionomics and control of the pink bollworm under the direction of Mr. P. B. Richards. The cost of the investigations for the entire period was about eight lakhs of rupees borne jointly by the U. P. Government and the Indian Central Cotton Committee.

Observations and experiments, both in the laboratory and in the field, showed that the pink bollworm was a major pest of cotton in the U. P.; which damaged cotton crops to the extent of 20 to 100 per cent. in different areas and seasons. Estimates made from 1925 to 1932 showed that the cash value of the loss due to this pest ranged from over $\frac{1}{2}$ to 2½ crores of rupees in different years, the lower figures of losses being also attributable to the reduced areas under cotton, as a result of the pink bollworm attack.

Extensive studies on the biology of pink bollworm showed that the main source of the infection of the new crops was the cotton seed in which the pest passed most of the winter and spring and from which it emerged as moth at the break of the monsoon to lay eggs on the plants and to start its cycle of life and damage again. The work in the United Provinces further showed that the most effective method of controlling the pink bollworm was to treat the cotton seed before sowing in such a manner as to kill the living larvæ inside them without impairing their germinating capacity.

Work in Egypt and other countries had shown that pink bollworm could not withstand a

temperature of 140° F. for any length of time and that even lower temperatures, not below 120° F., could prove lethal to the larvæ provided exposure of seeds to heat was prolonged. Starting on these premises, and after extensive tests and trials, it was established that in the United Provinces the sun heating of cotton seeds in April and May could effectively destroy the resting larvæ in them. It was also suggested that the application of heat by special machines to all commercial seed after ginning should be desirable and that the importation or retention of infected seed after a given date should be prohibited.

During the period of 12 years intervening between 1926 and 1938, extensive tests and field-scale trials were made to assess the effect of seed treatment on the incidence of the pink bollworm. Starting in 1926 with a small, well isolated area of about 250 acres, the Agriculture Department of the United Provinces extended the area under field control of the pest to about 50,000 acres, spread over about 1,000 sq. miles, in 1938. The results were stated to have shown that the average increased value of cotton per acre, during the period 1926-35, as a result of the treatment of seeds to rid them of the pink bollworm, was Rs. 23-13.

The latter years of the investigation were marked by some controversy within the Province as to the methods to be adopted to enforce the treatment of the cotton seeds to destroy the pink bollworm inside them. The desirability of legislation to compel the ginning factories to heat their ginned seeds before passing them out was hotly contested. Opinions seemed to be sharply divided on some other points also.

Early in 1943, when much of the controversy had died down, the Government of the United Provinces launched a new scheme, based on the results of the old work, to control the pink bollworm pest in certain selected areas, comprising a total of 1,115 villages with about 20,000 acres under cotton, under which cotton growers were supplied sun-treated or larvæ-free seeds for sowing on attractive terms. Persuasion and propaganda, rather than compulsion in any form, was the main plank of this scheme. This scheme is still in progress but it is too early yet to adequately demonstrate its usefulness by figures of yield and price.

Expansion of Vanaspati Industry

To ensure an ordered development of the *vanaspati* industry in India consistent with the demand for vegetable oil and the supply of machinery and raw materials, the Government of India have appointed a committee to plan the future expansion of the industry. The Committee will, *inter alia*, consider what further expansion is justified by deficiencies which are not met by milk ghee and edible oils, in what areas expansion should proceed in order to secure economic production and maximum benefits to consumers, how it should be phased with due regard to normal demand for *vanaspati* and the availability of manufacturing plants, what further steps should be taken to standardize production, whether protection is necessary to prevent unfair competition from established concerns, how the demand for technical personnel should be met, what assistance would be necessary from Government for orderly development of the industry and maintenance of high quality production, should the industry produce for the export markets, and to what extent efficient plants can be manufactured in

India and if Government can render any assistance in this connection.

The Chairman and Secretary of the Committee will be the Vegetable Oil Products Controller for India and the Director of Purchase of the Food Department respectively. Other members will be: a representative of the Education, Health and Lands Department of the Government of India and one representative each of the Bombay, Madras and Punjab Governments, Drs. B. C. Guha and V.K.R.V. Rao of the Central Food Department, Mr. Pettit of the Hindustan Vanaspati Manufacturing Co., Rai Bahadur Mahanarain of the Ganesh Flour Mills Co., Dr. D. Y. Athawale of the Harcourt Butler Technical Institute, Cawnpore, Dewan Kamakhya Datta Ram, Lucknow, and Rai Bahadur Harishchandra, Delhi, the last two to look after consumers' interests.

For the immediate needs of the country the Government of India are reported to have already decided to establish 27 factories with a total annual production of 105,000 tons.

Researches on Jute

A new scheme to explore the possibilities of evolving better species of jute by subjecting the seeds to X-rays, neutrons and γ-rays, submitted by the *Bose Research Institute*, was accepted by the Indian Central Jute Committee at the monsoon meeting held on 18th, July 1945.

Research schemes on impregnating bleached jute fibre with a synthetic resin, with a view to improving its textile qualities, investigations on the chemical utilization of jute waste and X-ray analysis of jute fibre, sponsored by Profs. J. K. Chowdhury, B. C. Guha and M. N. Saha, respectively, were continued for terms extending from one to three years. Prof. B. C. Guha's research scheme on the retting of jute was also extended.

It was decided to continue for three years, the Committee's scheme at Narsinghji for the testing out on a wider scale, under cultivators' conditions, the practicability of measures devised at the Dacca Laboratories, to control the pests and diseases of jute.

To remove the prevalent dearth of improved jute seed in Bengal, the Committee agreed to the proposal of the Director of Agriculture, Bengal, to help the Bengal Government in establishing a large jute seed multiplication farm in the Province. The Government of India approving, the Committee decided to make a grant of Rs. 50,000 to the Bengal Government as a permanent advance for five years in this connection.

In order to assist the jute cottage industry in Bengal in marketing their products, it was agreed that two co-operative societies of cottage workers should be established in Bengal, for two years in the first instance. It was suggested that the societies should try to obtain the sympathy and co-operation of the Bengal Industries Department in the task of improving the processes of spinning, dyeing and weaving.

The Jute Grading Sub-Committee's recommendation with regard to the commercial grading of raw jute on a five-grade basis was approved. It is understood, in this connection, that at the instance of the President of the Indian Jute Mills Association, who is the present Vice-President of the Indian Central Jute Committee, a meeting of the various interests concerned is soon being called with the view of getting the new scheme adopted by the trade, after modification if necessary, with effect from the next jute crop season.

Indian Central Cotton Committee

The monsoon meetings of the Indian Central Cotton Committee and its Sub-Committees were held in Bombay from the 23rd to 28th July, 1945.

Among the subjects that received the attention of the Committee, was that relating to the question of Indian representation at international cotton conferences. The Committee resolved to recommend to the Government of India that, at all future international cotton advisory committees and conferences, the Indian delegation should include at least one non-official member of the Indian Central Cotton Committee and that in the matter of giving directions to the delegation, the Indian Central Committee should be consulted.

The probable competition between cotton and synthetic fibres in the post-war years also engaged the attention of the Committee; it was agreed that the problem was one which demanded the earnest consideration of all cotton-growing countries. It was accordingly decided that all available information should be collected and placed before the Committee, particularly regarding the position in America which, in this respect, was similar to India, both being cotton-growing countries.

The annual progress reports on the work done during the past year at the Committee's Technological Laboratory and on the various research, seed distribution, marketing and crop estimating survey schemes financed by the Committee in the Provinces and States were reviewed and recommendations made regarding the future lines of work. A new scheme was sanctioned for the evolution of long-staple cotton of over 1½" in staple which at the same time combines the characters of hardiness and good yield and is suitable for growing under summer conditions in parts of Madras Province. The Committee also approved of a new scheme for the creation of a pure *Wagotar* cotton zone in the Mehsana District of Baroda State to cover an area of 70,000 to 80,000 acres.

Irrigation Research in India

The Research Committee of the Central Board of Irrigation met at Simla from 31st July to 4th August 1945, under the chairmanship of Mr. F. H. Hutchinson, Chief Engineer, P.W.D., United Provinces.

The Committee reviewed the progress of research at the seven research stations in India concerned with irrigation and river training.

The results of work done at these research stations have contributed to the success of the large irrigation undertakings in various parts of the country. For example, research into the flow of water in channels and transport of silt has enabled efficient channels to be designed which will not scour or become blocked by silt; in addition, sand excluders are now constructed at the headworks and sand ejectors in the canals. Uplift pressures on hydraulic structures founded on sand, is another subject, research on which has saved failures of all kinds of structures from small regulators to large barrages. Devices have been specially designed to measure the flow of water, and others to distribute it equitably and economically.

During the last few years special attention has been paid to the control of floods, and many problems await solution in connection with the utilization of water to its best economic advantage in combined purpose schemes embracing irrigation, hydro-electric power and flood control.

The Committee discussed the subject of Regeneration and Absorption in Rivers. With the increasing utilization for irrigation purposes of the supplies available in the rivers and the consequent complications in the division of available waters between different Provinces and States on a river system, this subject has come into prominence.

The effect of glaciers in the snow-clad Himalayas on the waters available for irrigation, and the possibilities of forecasting river supplies by snow surveys were discussed in a paper presented to the meeting by Rai Bahadur Kanwar Sain. The Committee undertook to make concrete proposals for country-wide investigations for estimating future river supplies from a study of rainfall, snow and glaciers data.

Another subject discussed at the meeting related to tube-wells, a large number of which are being installed all over the country in pursuance of the Grow-More-Food campaign. Methods of construction and maintenance to tube-wells, their optimum spacing in a grid system, and their effect on lowering the subsoil water table and thus relieving the waterlogging trouble which has followed canal irrigation in some parts of the country, were some of the questions discussed.

Progress was recorded on the investigations with regard to the science of flow in rivers and canals, and the Committee discussed various problems in connection with the design of irrigation channels and works thereon. Soil mechanics, lining of channels and materials for the construction of dams were some of the other subjects examined by the Research Committee.

The Committee also discussed the economic aspects of different kinds of flood control works with reference to the damage caused by floods, together with their effect on the regime of the river channel.

Technical Panel of the Food Department

A meeting of the Technical Panel of Scientists of the Food Department, was held in New Delhi on 11th August under the chairmanship of Dr. Sir Shanti Swarup Bhatnagar. The reports of various committees appointed to formulate proposals on methods of standardization of foodstuffs with regard to taste and smell, possible improvement of the alcohol industry in India, problems of insect infestation, manufacture of vitamins in India, the fortification of foods and the question of a permanent dehydrated food industry in India, were considered at the meeting.

The Vitamin Technology Committee has recommended that edible oils and *vanaspati* should be fortified with carotene or vitamin A depending upon the availability of material, that wherever there are big *ghee* heating centres, fortification with requisite amounts of vitamin A and D should be adopted, and that *atta* should be fortified with calcium carbonate. The Committee agreed that since it would not be practicable to fortify rice at present, other methods of providing vitamins and calcium to the rice-eating population should be introduced, e.g., in *dal* and other accessory food preparations.

As the establishment of a food yeast plant was under the consideration of the Government of India, it was agreed that regional feeding trials with yeast should be carried out in residential institutions. Finally, the Committee recommended to the Food Department that a mission of three officers of high standing and with the necessary background of experience in vitamins and allied subjects should be

sent overseas to work out details about the establishment of a vitamin manufacturing industry in India. It was agreed that steps would first have to be taken by the Government to buy the processes of vitamin manufacture from foreign firms and have their co-operation on a royalty or other suitable basis before the deputation is sent.

The Food Standards Sub-Committee has suggested that the Food Standards Section should form an integral part of an Institute of Food Technology when set up. It was recommended that an officer be appointed whose functions, *inter alia*, would be to appraise the various steps taken in different departments on the application of food standards on more scientific lines than has been done hitherto, to collect information of existing local and Provincial specifications and regulations under food laws, to make recommendations about food standards where sufficient information is available, and to indicate lines of future progress. It was agreed that the present work now being carried out in the Food Department for the establishment of tasting panel techniques suitable for application to Indian processed food-stuffs, should be continued as a help to the progressive development of a food industry in India. As a means of keeping constant check upon quality, it was considered desirable that a start should be made in the application of these techniques, wherever practicable, in the present food inspection system and by food processing concerns.

That hydrogenated vegetable oils provide a substitute for *ghee* in certain respects is recognized by the Hydrogenated Oils Committee of the Technical Panel of the Food Department. It was pointed out, however, that while some work has been done on the nutritional value of hydrogenated vegetable oils a great deal more is necessary. Recommendation has, therefore, been made, that researches be encouraged on the nutritional value of hydrogenated vegetable oils in comparison with vegetable oils and *ghee*, particularly on the effect of long-range feeding of hydrogenated vegetable oil on the growth and well-being of animals, on the relative utilization of important vitamins and minerals when *vanaspati* is fed and on the stability of vitamins in fortified hydrogenated vegetable oils.

In order to facilitate detection of adulteration of pure *ghee* with *vanaspati* which is practised on an extensive scale, it is recommended that further work should be done on the use of sesame oil, starch, etc., for admixture with *vanaspati* manufactured in the country.

The Technical Panel considered the report of its Sub-Committee on Alcoholic Beverages which recommended an improvement in the methods of manufacture of spirituous liquors in India. It has sometimes been thought that Indian rum contains more fusel oil, etc., than is desirable, but from the data at present available, it appears that the Indian product does not contain greater quantities of higher alcohols and aldehydes than rum of foreign manufacture. It was, however, strongly recommended that Indian rum should be matured at least for two years, and spirit from *mahua* should not be used in rum manufacture. Only sugarcane juice, *gur* or molasses should be used for the production of good quality rum and the practice of producing rum by mixing dilute rectified spirits should be discouraged.

In the case of brandy, the Sub-Committee recommended manufacture from grapes with the requisite period of maturation. Both in the interests of the consumer and the industry, it was opposed to the

use of diluted rectified spirit flavoured with essence of brandy. Similarly, in the case of whisky it was recommended that barley or other cereals should form the base.

To help in the standardization and improvement of the methods of manufacture of other indigenous liquors, Provincial Governments were to be addressed to supply information regarding the specifications of country spirits and their methods of enforcement.

Standards for Vegetable Oil Products

A notification published in the *Government of India Gazette* (28th July, 1945) prohibits manufacture of any vegetable oil product which does not fulfil, *inter alia*, the following conditions :—

(1) It shall not contain any harmful colouring or flavouring matter. (2) It shall not have a moisture content of more than 0.25 per cent. (3) Free fatty acids shall not exceed 0.25 per cent. (4) Its taste shall be free from staleness or rancidity, and (5) Its melting point shall be between 31° C. and 41° C.

The Botanical Survey of India

"Both Government Departments and the commercial public showed great keenness in the crude drugs of vegetable origin regarding their availability and quality," says the Report of the Botanical Survey of India for 1944-45. In the Pharmacognostic Laboratory, recently built under the auspices of a Calcutta firm, a number of drugs have been studied and the results published in scientific journals. Mr. Bal, being a member of the Indian Pharmacopoeial List Committee of the Government of India, carried out the pharmacognosy of a large number of Indian medicinal plants that are to be listed in the Indian Pharmacopoeial List, during the latter part of the year. A large number of economic inquiries relating to pharmacopoeial drugs, insecticides, rubber-yielding plants, plants used in perfumery trade and the like, were given to Government and the public. Numerous economic products were identified for official and non-official parties. The economic herbarium and the gallery received the necessary attention.

Floristic study in the field was again kept in abeyance on account of the war. A large number of specimens were, however, brought from the field for the herbarium by the Superintendent, Royal Botanic Garden, Sibpur, who made tours in the Darjeeling districts on behalf of the Government of Bengal.

Research in Minerals

Dr. Rm. Alagappa Chettiar has made a donation of Rs. 1,50,000 for founding a Chair for Geology in the Travancore University for research in minerals, in view of the possibilities of mineral research in Travancore and the consequent likelihood of a big commercial enterprise being started to process mineral products into finished goods.

This was announced by Sir C. P. Ramaswami Aiyar, Dewan of Travancore, while inaugurating the Perunchani Reservoir Scheme. The Dewan added that the Government of Travancore would be contributing an equal amount to make the scheme a success. An expert in the subject would be appointed and a geological survey and intensive research in minerals would be undertaken in the State. The Dewan also announced that the Government would establish two Chairs in the Travancore University, one in Geology and the other in Chemistry.

It was also announced that the Government had decided to give the Universities an extra grant of Rs. 50,000 per annum for three years, of which Rs. 40,000 would go for awarding Fellowships or Studentships to twenty selected candidates at the rate of Rs. 150 per mensem, to enable them to receive the best possible training in various branches of knowledge most suitable and useful to the State. The Fellowships and Studentships will be awarded for training in both the Travancore University and other University centres like Bangalore, Benares or Patna, where there might be facilities for specialized training.

It is understood that the mineral sands of Travancore will not be allowed to be exported hereafter in the form of raw sand. The Government would encourage establishment of factories for converting the sands into finished products, but as the formulæ for processing the sands were treated as secrets, such of the firms of individuals as had been dealing with this branch of manufacture might have to be called in to assist them in the exploitation of the sands and deposits, unless the researches carried out in the University made them independent of outside help.

Tata's Gift to Nagpur University

In response to an appeal from Mr. Justice W. R. Puranik, Vice-Chancellor of Nagpur University, *Tatas* have made a donation of Rs. 50,000 towards the establishment of a Department of Geology in that University, of which Rs. 40,000 comes from the Sir Dorabji Tata Trust. The Sir Ratan Tata Charities have also made a contribution of Rs. 5,000 per year towards the recurring expenditure of the Department for a period of five years.

Dam Across the Godavari

The final selection of a site in Ramayyapet village has been made in consultation with competent American engineers for the construction of a giant dam and reservoir on the Godavari. This was announced by Sir S. V. Ramamurti, Development Adviser to the Governor, in charge of Development, while inaugurating the new Government Agricultural College at Bapatla on 16th July.

The reservoir, which will be capable of supplying water as far north as Vizagapatam, and as far south in Guntur as Bapatla itself, is claimed to be a gigantic irrigation work vying with the famous Tennessee Valley Scheme in America. It will impound nearly five times the water which the Mettur Reservoir now holds and is estimated to cost Rs. 70 crores, three times the amount spent on all irrigation works so far in the Province.

H.E.H. the Nizam has sanctioned the Godavari Valley Development Scheme costing Rs. 24 crores. The scheme is expected to bring eight lakhs acres of land under irrigation in the districts of Warangal, Karimnagar and Adilabad, besides making available about 75,000 kw. of cheap electric power, enabling the establishment of a number of industries in the Godavari valley area. This is the first enterprise of its kind launched by any Government in India, resembling in its outline, though not in magnitude, the famous Tennessee Valley Scheme in America. The scheme originally planned by Col. Slaughter, Adviser to the Industries Member, H.E.H. the Nizam's Government, with the technical assistance of Nawab Ali Nawaz Jung, Nawab Zain Yar Jung and Mr.

Azzemuddin, envisages a heavy programme of industrial and agricultural development of the Godavari valley with Antargaon (Adilabad District) as the pivot, by means of a combined hydro-electric and irrigation project. This area has been specially chosen by virtue of its proximity to coal and iron fields, and such raw materials as limestone, soapstone, fireclay, timber and cotton, besides plenty of water supply. The scheme also proposes two new railway lines, one running west linking the industrial city with the Bombay line at Kudwad and the other running eastwards linking it up with Vizagapatam via Bastar Agency.

H.E.H. the Nizam has appointed Nawab Mohamed Yar Jung Bahadur, Secretary, Post-war Planning Department, as the Chief Commissioner, Godavari Valley Development Scheme.

Tungabhadra Project

H.E.H. the Nizam has sanctioned a sum of Rs. 40,20,000 for meeting the preliminary expenditure on the Tungabhadra Irrigation Project. An administrative circle, with two divisions, has been created to undertake the work, entailing an expenditure of Rs. 2,42,000 during the first year.

Training in Inland Fisheries

In furtherance of their Food Production Campaign, the Government of India have placed a sum of Rs. 28,000 at the disposal of the Bengal Government to meet the cost of the Inland Fisheries Training Scheme, Calcutta, for the second course which commenced on 1st August 1945. Out of this amount Rs. 14,000 will be recovered in due course from the participating Provinces and States. The above grant is for a complete course of six months.

Future of War-time Industries in India

There is some natural anxiety among producers and manufacturers that the end of the war and the cancellation of orders for war supplies may mean the end of the assistance which they have had from Government in obtaining materials and other resources, and with transport, for the production of war supplies.

Government wish, therefore, to reassure producers and manufacturers that, so long as the various controls remain in force, they will endeavour to give assistance for the production of civil supplies in the same way as previously of war supplies, by provisioning and allocating essential materials such as coal, steel, cement and timber, procuring capital equipment and tools, obtaining transport priority, etc.

Government have instructed the Directorates in the Department of Supply that such assistance must continue, for the restoration of industry, its conversion from war to peace, and for its expansion. Producers and manufacturers should, therefore, apply to the appropriate Directorate for the assistance they require, in order to get their shares in the allocation of available materials, etc.

For the procurement of stores to meet post-war Government requirements, the policy of Government is to make the greatest possible use of indigenous production, and particularly of those industries which have, under the influence of war needs, achieved production conforming to acceptable standards and specifications. While commodities paid for from

the public purse must in general be the best that can be produced at the price, it is the aim of Government to establish continuity of procurement from industries which maintain a consistent performance, and which pay attention to new modifications and developments.

Control on Coal Mining Operations

The Government of India, in consultation with the Coal Control Board, have decided to take steps to set up a machinery to control the opening and reopening of coal mines.

Large numbers of small pits and quarries have been started in recent months which drain away coal mining labour from established collieries and, with inefficient methods, produce only inferior classes of coal.

The Colliery Control Order, 1944, has, therefore, been amended by inserting the following clause : "No colliery shall be opened, and no colliery, working whereof has been discontinued over a period exceeding two months, shall be reopened except with the previous permission of the Central Government and in accordance with such directions as the Central Government may at the time of granting permission or subsequently give to the owner or the owners concerned.

It is not the Government's intention to ask for information in great detail from persons desirous of opening or reopening coal mines. Control will be restricted to requiring the owner or the proprietor to give prior notice and to obtain the Coal Commissioner's approval to commence mining operations or to reopen a mine in any particular coal-bearing area in a prescribed form available from the Regional Coal Controller of the area concerned. Permission to open or reopen will be given by the Coal Commissioner after consultation with the Chief Inspector of Mines in India.

Technical Training for Craftsmen

An apprenticeship training scheme, planned and organized on national basis and leading to a certificate of craftsmanship on the completion of training, has been recommended to the Central Government by the Technical Training Scheme Advisory Committee, at their meeting held last month at New Delhi, under the chairmanship of Mr. S. Lall, Additional Secretary to the Labour Department of the Government of India.

The scheme is intended to ensure a steady flow of trained craftsmen into industry and to meet the industry's present and future needs. Before devising the plan the Committee made a rapid survey of the number of technical personnel employed in private and Government engineering workshops. This survey showed that after allowing for the annual output of the existing factory apprenticeship schemes and industrial and trade schools in the Provinces, a large number of skilled workers was still required by industries to maintain their present strength. In addition, skilled workers will also be required to meet the expansion of existing industries and of the new industries that may be started in the post-war period.

Recognizing that the best way of providing good craftsmen is through comprehensive and systematic apprenticeship, the Committee have advocated that the first part of training would be given in specially designed centres to be run by Government, and the

second in workshops engaged on production, thus co-ordinating training and production to the greatest possible degree. The total duration of training should be $3\frac{1}{2}$ years of which the trainees should spend the first two in a Government training centre and the balance as an apprentice in a factory. While the training centre should provide practical training closely related to industrial practice, attention should also be paid to theoretical subjects.

The Committee recommend that as a starting measure steps should be taken to open one centre each in Bengal, Bombay, Madras, U.P., Punjab, Bihar, Delhi and Central Provinces. In all they will provide a seating capacity of about 4,000 and the annual outturn from these seats will be about 2,000 craftsmen.

In each Province or Region there should be a Provincial or Regional Technical Committee to deal with the local administration of the scheme, to supervise training, to arrange for trade tests and for providing apprenticeship training to trainees who complete their training satisfactorily at the centre. These committees should consist of representatives of Central and Provincial Governments, private and Government industry, the workers, the Institution of Engineers and the Regional Inspector of Technical Training. Generally speaking, the scheme should be open to all who may wish to qualify themselves for industrial employment. In view, however, of the fact that employers generally give preference to the sons and relatives of their workers, the Committee recommend that up to a maximum of one-third of the candidates should be from amongst applicants who are the sons and relatives of employees of firms participating in the training scheme.

The age limit for admission to the training centre should be from 14 to 18 years. Boys admitted to the training centre should be required to have studied up to a standard two years below the matriculation or its equivalent. In the early stages it may be necessary to make relaxations in educational standards. The Committee also emphasize the importance of physical fitness of the trainees.

Syllabuses of training have been drawn by the Committee on the basis of the experience of war-time technical training schemes and in consultation with employers all over the country. The engineering trades have been divided into two groups, each group being concentrated around a "foundation trade." The intention is that there should be a basic training period of six months. It is proposed to impart training in 22 engineering trades. The Advisory Committee have recommended that the scheme should also include textile, leather and printing trades.

An employer who participates in the scheme will have the advantage of obtaining workmen who have been partially trained at the expense of Government. He is, therefore, required to provide apprenticeship training not only for those candidates who are admitted to a Government training centre from his factory, but also for an equal number of other candidates from the training centre. For the remaining trainees arrangements should be made in other factories with the help of employers' associations.

Provision has also been made in the scheme for general educational instruction during factory training, adequate hostel arrangements, stipends and factory clothing. The Committee recommend that

there should be an apprenticeship agreement between the Central Government, the employer, the apprentice and his guardian.

After the satisfactory completion of apprenticeship training, the trainees will be awarded a National Certificate of Craftsmanship by the National Council for Technical Education, which, the Committee hope, will be set up in pursuance of the recommendations made by the Central Advisory Board of Education. Provision has also been made in the scheme for the training of instructors and the Committee has unanimously recommended the establishment of a special training centre for this purpose.

Thus the salient features of the scheme are : (1) It ensures close co-operation with employers and (2) it provides for the sharing of responsibility for training craftsmen between training centre and the factory. It will serve as an important link between educational and pre-vocational institutions, on the one hand, and industry on the other. Since the report of the Central Advisory Board of Education specifies a two years' course, after the Senior Basic School stage, for industrial and trade schools, and since these schools and the proposed training centres will come under the control of the National Council of Technical Education, it is obvious that industrial schools and training centres will be providing similar courses on parallel lines and they will both lead to the National Certificate of apprenticeship.

The Committee are of the view that as the scheme attempts to impose a measure of control over apprenticeship, legislation may be necessary. This should, however, be on the basis of the recommendation of the Regional Committees.

Minor Iron and Steel Industries

Questions relating to the post-war development of the hardware, hollowware, haberdashery, enamelware, cutleryware industries and industries dealing with the manufacture of surgical instruments, steel furniture and fittings, were discussed at a recent meeting of the Iron and Steel (Minor) Panel in New Delhi.

After considering the current position and organization of these industries, the Panel decided to issue questionnaires to firms manufacturing stores covered by the industries. It was also decided to form zonal sub-committees, from the members of the Panel, in Bombay, Calcutta, Madras and Lahore. The function of these committees will be to give the widest publicity to the questionnaires among manufacturers, so that the maximum possible information could be made available to the Panel to decide upon the line of action to be taken to develop these industries to their full capacity.

U.N.R.R.A. Mission in India

The U.N.R.R.A. Mission headed by the Hon. Francis B. Sayre, which arrived in New Delhi on 10th July 1945, left on 29th July, by air to Cairo. Mr. Rajaram V. Gogate, one of the members of the Mission, is still in India to complete the work of the Mission.

The main object of the Mission was to explore the possibilities of purchases in India of essential commodities which this country can spare and which are needed for the relief of the countries freed from the enemy.

India's contribution to the Administration, as approved of by the last budget session of the Assembly, is Rs. 8 crores. The Government of India indicated that their policy was to restrict purchases to those goods, raw or manufactured, which were not in short supply and which could be safely spared without causing hardship to the Indian consumer or adversely affecting the Indian economy. The question of supplies should be reviewed periodically and every endeavour should be made to regulate the purchase of relief materials in a manner which would best serve the economic interests of the country.

As a result of the discussions, it was agreed that the following goods could be supplied to the U.N.R.R.A.: pepper (1,000 tons, Rs. 15 lakhs); tea (2½ million lbs., Rs. 22 lakhs); raw cotton (9,000 tons, Rs. 125 lakhs); cotton waste (500 tons, Rs. 3 lakhs); raw jute (10,000 tons, Rs. 50 lakhs); linseed (5,000 tons, Rs. 17½ lakhs); peanuts (70,000 tons, Rs. 225 lakhs); coir yarn (150 tons, Rs. 1 lakh); and jute manufactures (20,000 tons, Rs. 200 lakhs).

All purchases for or on behalf of U.N.R.R.A. in India will be made by the Government of India, which will be responsible for handling and storage of the goods until they are finally loaded in the vessel.

The U.N.R.R.A. is the first operating United Nations Organization actually at work in bringing relief to stricken victims of war through international co-operative efforts. The year 1945-46 will be crucial years for the Administration. The U.N.R.R.A. had shipped by the end of June, some 125,000 long tons of relief goods and through sending technicians and experts to help meet distress situations, through its medical and public health works and through its care and repatriation of millions of displaced persons, the U.N.R.R.A. is doing monumental work and laying a solid foundation for an enduring peace.

Film Delegation to Britain and U.S.A.

A delegation of the Indian Film Industry (Mr. P. N. Roy, *leader* and Mr. K. S. Hirlekar, *Secretary*) is now touring in the United Kingdom and the United States of America. The object of the visit is to study the latest developments in the film industry, both from the technical and organizational points of view, and to collect information about the film training institutions and research laboratories.

While in the United Kingdom, the delegation visited the leading British film studios, laboratories and factories producing raw material and machinery required for the film industry. The delegation was well received everywhere. The members have already collected much useful information, which will be of value in planning the development of the Indian film industry.

Indo-Canadian Trade in 1944

From the latest particulars available of Indo-Canadian trade, it is seen that the total of this trade for 1944 was valued at \$202,672,000, an increase of \$51,006,000 over 1943 and of \$13,442,000 over the previous all-time high figure of \$189,230,000 recorded in 1942. Imports into Canada from British India, amounting to \$27,878,000, were \$10,788,000 greater than in 1943, while exports from Canada to this country valued at \$174,794,000, recorded an increase of \$40,218,000 over the previous year.

Although tea and jute products continued to be the main imports from India, improved shipping facilities from the East during the year resulted in increased quantities of these products being imported. Shipments of other regular items of import from India were also greater and many articles of Indian origin were brought to Canada again after an absence of well over a year. Indian peanuts were imported in large quantities during 1944 for the first time since 1942, when the Canadian Government placed a ban on the import of these nuts. Indian raw cotton and kapok were other articles in this same category. Imports of rugs and manganese oxide also greatly increased. On the other hand, Indian vegetable oils showed a further decrease and were practically negligible during 1944.

Canadian exports to British India during 1944 showed an increase of \$6,910,000 over the previous record year of 1942 (\$167,884,000) largely in mechanical transport and parts, locomotives, textile products, non-ferrous metals and products, food products, wood products and paper.

International Labour Organization

The 27th session of the International Labour Conference will be held in Paris. The session will open on 15th October 1945, and will probably terminate on 7th November 1945.

"The Governing Body of the International Labour Organization have decided to set up, within the framework of the Organization, International Industrial Committees with a view to providing specialized machinery to consider the problems of certain of the major world industries," says a Press *communiqué*, issued by the Labour Department, Government of India, on 9th July.

"The Committees will be tripartite, comprising representatives of Governments as well as of employers and workers, subject to the right of each committee to appoint bipartite sub-committees or to arrange for parts of its meetings to be bipartite. The responsibility for appointing the employers' and workers' members of the Committee has been left to the Governments, who will make the appointments in agreement with the principal organization of employers and workers having a substantial membership in the industry concerned. Each Committee will include a delegation of the Governing Body comprising an equal number of representatives of the Government group, the employers' group and the workers' group.

"The Committees will be set up, in the first place, in the following industries: (a) Inland transport (all forms of transport, including air transport, except maritime transport, which is covered by the Joint Maritime Commission); (b) Metal Trade (sub-committees may ultimately be set up for various branches of the metal trades, e.g., shipbuilding, aircraft manufacture and automobile manufacture); (c) Coal Mining; (d) Textiles (sub-committees may ultimately be set up for various branches of the industry); (e) Iron and Steel Production; (f) Petroleum Production and Refining; and (g) Building, Civil Engineering and Public Works.

"India has been invited to participate in all these Committees, except the one on the Petroleum Production and Refining. All the Committees on which India has been invited to be represented are world-wide in scope."

Announcements

Irrigation in India.—Sir William Stampe, Irrigation Adviser to the Government of India, accompanied by the Technical Adviser to the Irrigation Department of the Government of India, is visiting Britain and America in connection with the purchase of machinery required for irrigation.

In an interview to the A.P.I. correspondent in London, Sir William, giving details of his mission, said: "During the war years, India has been carrying out her irrigation schemes with equipment similar to that described in the Bible. There have been many developments in the methods of irrigation and irrigation machinery during the past five or six years and I am setting out on a tour of British and American factories to study their latest technical improvements. I shall have to find out whether the plants manufactured in the two countries can be adapted to India's needs. If not, a special plant will have to be devised. Immediately I am in a position to make my report to my Government, orders will be placed in both countries for necessary plant.

"The plant for sinking tube-wells and for water boring in parts of India hitherto unused for water production, will play an important part in India's food self-sufficiency plan. The next two years will be vital, and we want to speed up the campaign by every means at our command."

Institution of Chemists (India). At a meeting of the Council of the *Institution*, held at Calcutta on 30th June 1945, it was decided to award, annually, a medal called *H. K. Sen Memorial Medal* to an eminent industrial chemist, selected by the Council of the *Institution*. The recipient of the medal would be requested to deliver a memorial lecture. The cost of the medal would be met from the funds of the *Institution*.

Indian Institute of Science, Bangalore. Sir M. Visvesvaraya was re-elected President of the Court for 1945-46, at the annual meeting of the Court held at Bangalore on 2nd July 1945.

Central Advisory Board of Education. The following have been renominated by the Governor-General-in-Council as members of the Central Advisory Board of Education in India for a period of three years, with effect from the dates shown against their names:—

1. Gaganvihari L. Mehta, Esq. (from 6th June, 1945). 2. P. F. S. Warren, Esq. (Cantab). (from 6th June, 1945). 3. Sardar Bahadur Ujjal Singh (from 20th November 1945).

Mr. J. A. Rahim, I.C.S., Deputy Secretary, Supply Department, has been appointed Indian Government Trade Commissioner, Alexandria, to succeed Mr. I. Majid.

Erratum

This Journal, Vol. 4, No. 1, July 1945, page 13, Table II.

The values for the Final D.R.C. of Latex in Nos. 7-13, should be 14.1, 14.8, 13.8, 14.4, 14.8, 6.8 and 6.7 respectively.

Page 14, Table V,

The values for the Final D.R.C. of Latex in Nos. 7-12 should be:

13.2, 14.0, 14.5, 12.9, 13.1 and 13.1 respectively.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for the period June–July 1945.]

31074. AN IMPROVED DECARBONISING PROCESS (addition to No. 30471): *Applying to the metal parts a composition comprising a coal tar distillate and a surface tension reducing agent—dispersed therein.*—Lunt.
31096. CONVERSION OF FLUID REACTANTS IN THE PRESENCE OF SUBDIVIDED SOLID CONTACT MATERIAL: *Employing a fluid-like bed of solid contact material in two confined zones, passing a stream of said solid particles from each bed into the other bed.*—Universal Oil Products Co.
31104. MINERAL SEPARATIONS: *Mixed with agents for froth flotation and then separated over concentration table.*—Holman Bros. Ltd. and Michell.
31130. CONTINUOUS DIFFUSION PROCESS FOR SUGAR EXTRACTION: *Treatment in several stages the cossettes and diffusing juice moving in counter current.*—Silver.
31145. GUSSET-TYPE BAG STRUCTURES: *Two-ply gusseted bag, inner of synthetic material closed by flat contact and outer of paper closed by folding four rectangular flaps.*—Wingfoot Corp.
31161. APPARATUS FOR DELIVERING A LIQUID IN MEASURED QUANTITIES: *Measuring chamber having inlet and outlet, composite plug cock and control means.*—Textile Appliances Ltd. and Stalker.
31310. TELECOMMUNICATION SWITCHING SYSTEMS: *Electronic switch for testing the line.*—Standard Telephones and Cables Ltd.
31311. TELECOMMUNICATION SWITCHING SYSTEMS: *Controller for variably operating the register.*—Standard Telephones and Cables Ltd.
31343. DIPPED ARTICLES OF PLASTICIZED SYNTHETIC RESIN: *Dipping a form into the solution containing vinyl halide resin and plasticizer.*—The Glenn L. Martin Co.
31403. PLASTICIZED SYNTHETIC RESIN COMPOSITIONS: *Comprising vinyl halide resin, plasticizer, plasticizer sealant and a chlorinated hydrocarbon.*—The Glenn L. Martin Co.
31414. BENEFICIATION OF IRON ORES BY FROTH FLOTATION: *Treating with a mixture of water soluble and oil soluble sulphonates.*—American Cyanamid Co.
31472. BEST CONTROL COMPOSITIONS: *Fertilizer with which is incorporated an halogenated compound.*—I. C. I. Ltd.
31473. ARTIFICIAL PROTEIN FILAMENTS: *Filaments under stretched condition and at raised temperature are treated with formaldehyde and thereafter withdrawing the tension.*—I. C. I. Ltd.
31536. DESIGN AND MANUFACTURE OF PRE-STRESSED CONCRETE STRUCTURES SUBJECTED TO BENDING MOMENTS IN TWO OPPOSITE DIRECTIONS AND TO SHEAR ESPECIALLY RAILWAY SLEEPERS OR THE LIKE: *For acting eccentrically major pre-compression counteract the tensile stress due to load and minor pre-compression added to the compression due to the load.*—The Pre-Stressed Concrete Co., Ltd. and K. W. Mautner.
31560. BUILDING MATERIAL MADE FROM LAYERS OF CORRUGATED MATERIAL AND SHEETS: *In layers of unimpregnated corrugated material between sheets of covering materials, the axes of corrugations in one or more layers disposed at an angle.*—Hofheimer.
31646. APPLICATION OF LUMINOUS COMPOSITIONS: *Dusting the luminous composition in powder form on an adhesive composition on the article.*—Thorium Ltd.
31674. ELECTRIC SUCTION CLEANERS: *Distance between brush and surface to be cleaned regulated automatically.*—G. E. C. Ltd.
31719. TREATMENT OF TEXTILE MATERIALS TO REDUCE THEIR TENDENCY TO FELT: *Treating textile material with anhydro-carboxyglycine.*—I. C. I. Ltd.
31854. SIGNALLING DEVICE FOR BICYCLES OR MOTOR CYCLES: *Tube-shaped handle bars with openings, or the grips, exposed to the light of the lamp within them, are translucent.*—Davidson.
31857. PLASTICIZED SYNTHETIC RESIN COMPOSITION: *Comprising a vinyl halide resin and a plasticizer.*—The Glenn L. Martin Co.
31889. A RETAINING MEANS FOR BADGES, BROOCHES, ORNAMENTS, BARS FOR DECORATIVE RIBBONS OR THE LIKE: *Pins hingedly mounted on the back of the badge or the like and springy locking strip.*—Madger.
32002. CHANGE-SPEED GEAR OF MOTOR VEHICLES: *Synchromesh change-speed gear having friction device readily applied and replaced.*—The Austin Motor Co., Ltd.
32059. INDICATING SYSTEMS FOR ELECTRICAL SIGNALS: *Indicating system distinguishing electric dash and dot signals by applying the signals to a d.c. indicator through oppositely directed rectifiers paths.*—Standard Telephones and Cables Ltd.
32064. SULPHANILAMIDE DERIVATIVES OF THIOUREAS AND THIAZOLES: *Causing p-substituted benzene sulphonyl-thioureas obtained by reacting sulphonyl-cyanamide with ammonium sulphide to react with dichlorether or a chloro-vetone.*—Bengal Immunity Co., Ltd.
32143. TELEGRAPH TRANSMITTERS: *Automatic telegraph transmitter, marking and spacing effected by perforated tape controlled photo-electric cells.*—Marconi's Wireless Telegraph Co., Ltd.
32169. TERTIARY ARYLAMINES: *Causing mono-salts of X—R—Y wherein R stands for alkyl chain, X for secondary arylamino group and Y for a basic group to react with esters of alcohols.*—Society of Chemical Industry in Basle.
31197. WEIGHT-TRANSFERRING VEHICLE COUPLING OR HITCH STRUCTURE: *Expanding and contracting chamber receivable of fluid under pressure to energize the structure for transmitting weight from one vehicle to other.*—Simmons.

31266. VARIABLE SPEED GEAR: *Driving shaft and countershaft are supported at each side of and in close proximity to the constant mesh gears.*—Guy Motors Limited and others.
31593. PISTONS FOR INTERNAL COMBUSTION ENGINES AND THE LIKE: *As a reinforcement, a flange or rib at the end of each of the gudgeon pin bosses adjacent to the axis of the piston.*—Specialloid Limited.
31641. EXPLOSIVE COMPOSITIONS: *Explosive composition including in finely divided form one or more of the oxides of a metal.*—E. I. Du Pont de Nemours & Co.
31714. ELECTRICALLY CONTROLLED SLIDE ACTION MACHINES FOR WEIGHING GOODS TO A PREDETERMINED NETT WEIGHT: *Vertical notched slide bar and release lever operated electromagnetically.*—Wilson.
31801. JETTIES, WHARVES AND LIKE BERTHING PLACES FOR VESSELS: *Furnished with fenders suspended by chains or other flexible elements.*—Baker.
31960. MANUFACTURE OF ICE: *Ice forming means consisting of more than one can of graduated sizes enabling quicker formation of ice blocks.*—Manohar.
32090. REGENERATING FUSIBLE BLANKET FOR PROTECTING THE SURFACE OF GALVANIZING BATHS: *Molten blanket composed of alkali-metal chloride, zinc chloride and ammonium chloride.*—Dewey and Almy Chemical Co.
32148. HYDRAULIC JACKS PARTICULARLY FOR VEHICLE TIPPING GEAR: *Jack having pressure relieving means automatically operated by supplementary movement of Jack at extension stroke end returning excess operating fluid to low pressure reservoir.*—Houldsworth.
32179. SUBSTITUTED QUINOLINES AND NEW ANTIMALARIALS: *6-substituted 4-[W'-(N-piperidino) alkylamino] quinolines, having antimalarial properties are produced by condensing 6 alkoxy-4 chloroquinolines with an N-substituted diamine.*—Eli Lilly and Co.
32571. APPARATUS FOR DELIVERING A LIQUID IN MEASURED QUANTITIES: *Air admission means in measuring chamber comprises an air-admission passage partly rotatable plug-cock and means for effecting part rotation of plug-cock.*—Textile Appliances Limited and anr.
30618. FOUNTAIN PENS: *Ink reservoir consists of a group of duct sections.*—Martin.
31117. SELF-DRAINING FLOORING: *Wearing surface has multiplicity of groups of inclined planes sloping downwardly to draining outlet.*—Gogerly.
31118. SPOT WELDING MACHINES: *Comprising in combination a latch co-operating with the pedal, means for moving the latch and means for releasing the latch.*—The Rose Street Foundry and Engineering Co., Ltd.
31136. TEMPORARY COUPLING BETWEEN FLUID DELIVERY MEANS AND FLUID RECEIVING MEANS: *To make fluid-tight joint with a male coupling member a female coupling member having a tubular body with piston a seat and jaws with springs.*—Neuman.
31635. A CALCULATING SLIDE RULE FOR THE INDIAN CURRENCY, WEIGHTS AND MEASURES: *Scales having two sets of sixteen logarithmic divisions.*—Datta.
31570. VITAMINISING OF OILS AND FAT MEDIA, PARTICULARLY EDIBLE OILS AND COOKING FAT MEDIA: *Heating vitamin containing vegetables in contact with oil or fat.*—The Swastik Oil Mills Ltd.
31640. SYNCHRONISING CIRCUIT FOR MULTIPLEX MODULATED PULSE COMMUNICATION SYSTEMS: *Signals of each channel spaced by determined time interval.*—Standard Telephones and Cables Ltd.
31837. VOLTAGE STABILISING CIRCUITS: *Battery or neon tube applies bias to thermionic valve in control circuit.*—The Mullard Radio Valve Co., Ltd.
31895. LOCKS: *Series of laminae, a shackle having a notch, a locking plate, an operating plate control levers.*—Ahmed.
32010. REFINING OF TIN-BASE WHITE METALS: *Covering the alloy with stannous chloride flux and bubbling air through molten mass.*—J. Stone & Co., Ltd.
32070. PESTICIDAL COMPOSITION AND METHOD OF APPLYING IT BY DISPERSION: *Smoke forming substances are used along with insecticides for determining the location reached by a dispersed spray of any insecticide.*—Walsh.
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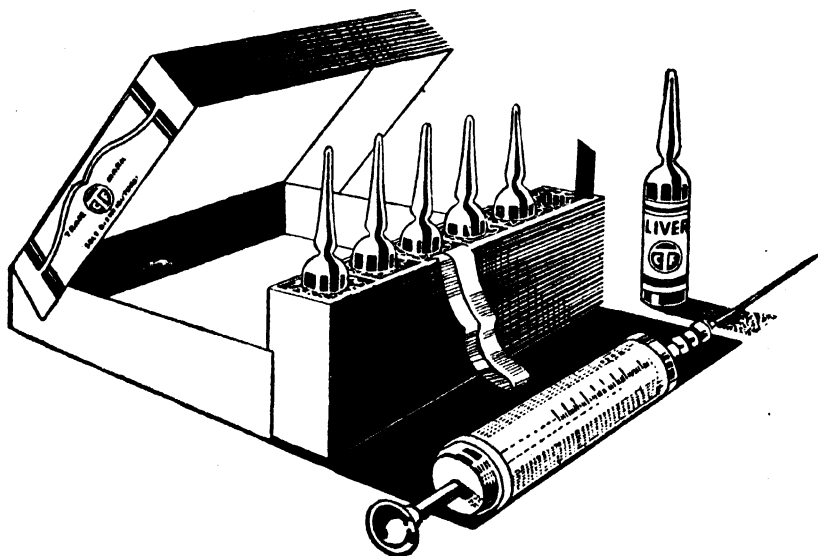
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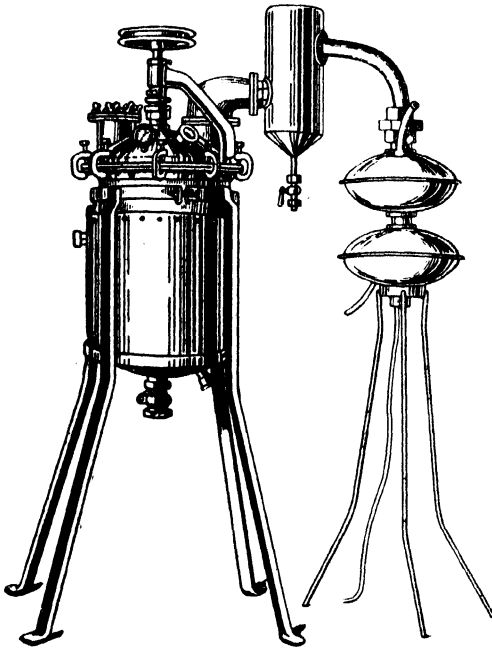
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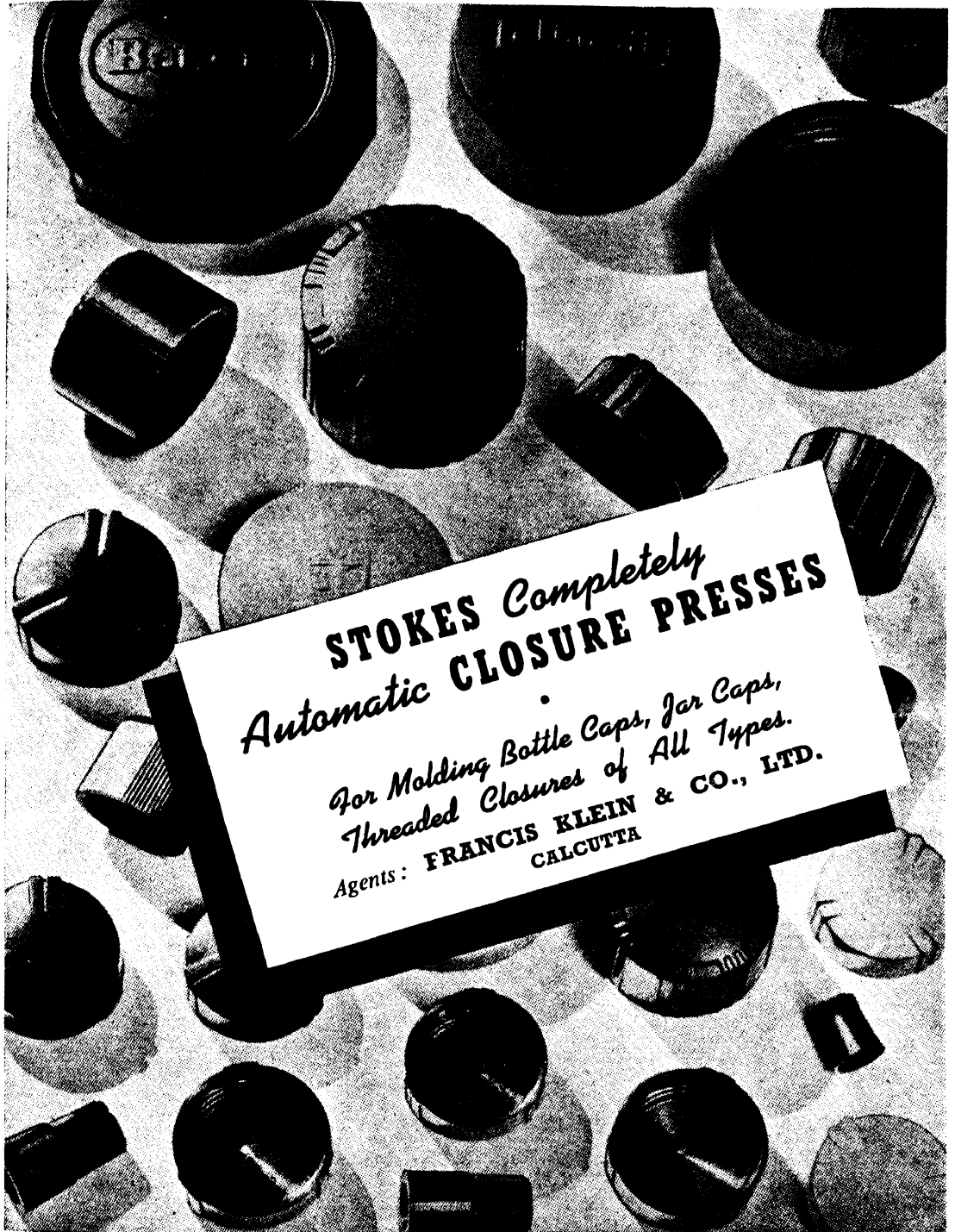
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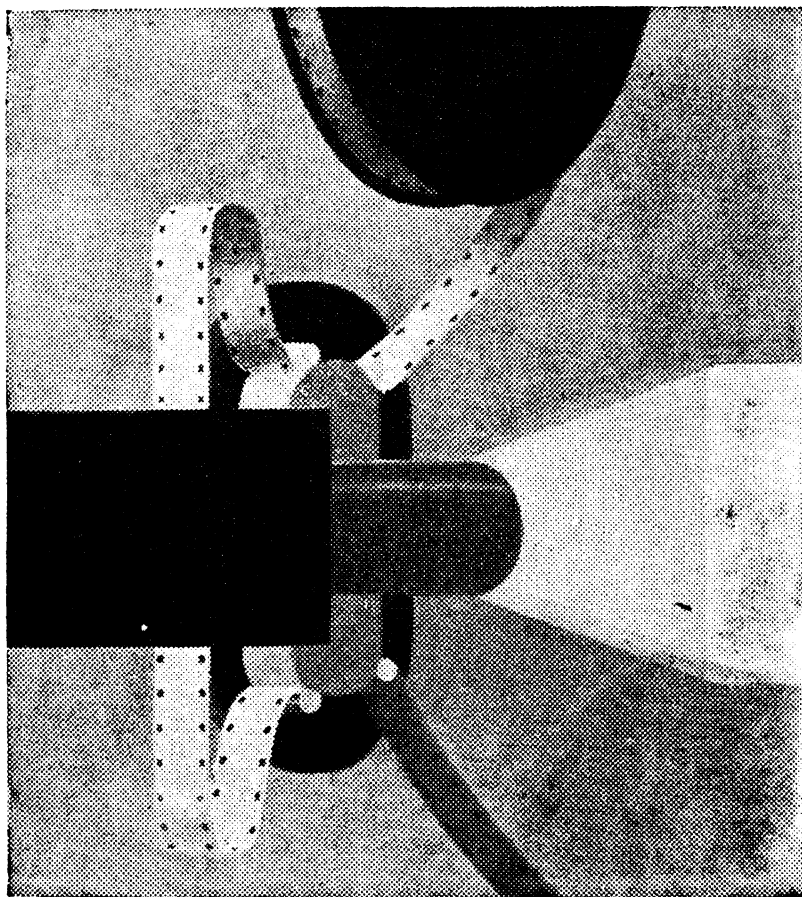


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debt. Celluloid itself, the basis of the industry, is a chemical achievement. This must be transparent to give clear images after great magnification, resilient and tough to stand great strain. It must be so treated that the danger from fire is reduced to a minimum. The hand of the chemist is indeed traceable from the make-up of the actors to the lamps in the projectors. In the apparatus used for the sound-recording rare metals are needed: in the lenses of cameras and projectors, optical glass of the highest quality: in the colour-photography, pigments of the truest and most vivid colour. The sets for the ball-rooms and palaces of the cinema's Cloud-cuckoo-land involve the use of large quantities of paints, quick-drying stucco and plasters: the costumes and draperies must be dyed. The tale is continued into the cinema theatre itself, in its decoration, its disinfection, its air-conditioning. When next you sit in your favourite cinema, think for a moment of the patient work in laboratory and factory that has enabled you to see the wonders of the world or the finest product of the cinematograph studio so clearly and still at so modest a price.



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Journal of Scientific and Industrial Research

MAGNETIC STUDY OF COLORANT IONS IN COLOURED GLASSES

By **S. S. BHATNAGAR, BRAHM PRAKASH AND
JAI CHAND MAHESHWARI**

*(Council of Scientific and Industrial Research, Delhi, and the University Chemical
Laboratories, Lahore)*

THE study of colours of glasses and minerals has suffered from the failure to tackle fundamental problems. Much attention, for example, has been given to the possibility that manganese is responsible for the colour of the amethyst¹. The more recent evidence suggests iron rather than manganese as the colorant², though Sir Herbert Jackson³ does not consider the evidence conclusive. It, therefore, becomes necessary first to study the precise role of colorants in simple glasses and to apply the information thus gathered in explaining the colour of minerals and rocks. Glasses are simpler than minerals because the colouring agent is ordinarily known to start with.

It is a curious fact, however, that a particular colouring agent is capable of giving a variety of tints to glass under different conditions. Thus according to Mellor, manganese colours alkaline glasses pink to violet under oxidizing conditions. The colour has been called amethyst in lead, bluish-violet in potash and reddish-violet in soda glasses. The colour is completely obliterated under reducing conditions. Similarly, copper colours glass blue to a light apple green; iron exhibits yellow, green and blue colours and chromium presents a variety of shades varying from yellow to bluish green.

The exact cause of these variations in tint is not well understood but must obviously be connected with the changes in valency since it is remarkable that the metals employ-

ed as glass colorants are, in general, capable of exhibiting varying valency states.

Among the more recent methods employed for the determination of valency may be mentioned the magnetic method. It affords valuable information about the valency, particularly of the paramagnetic ions. Van Vleck⁴, Sommerfeld⁵, Bose⁶ and Stoner⁷ have obtained the following derivation for the paramagnetic susceptibility of the ions* :—

$$\chi_M = \frac{NB^2}{3KT} [4S(S+1) + L(L+1)]$$

where the orbital moment is fully quenched by interaction with neighbouring atoms or ions, the expression reduces to :

$$\chi_M = \frac{NB^2}{3KT} [4S(S+1)]$$

Alternatively, the magnetic moment is expressed in Bohr units by the relationship

$$\mu_B = \sqrt{4S(S+1)L(L+1)}$$

which reduces to :

$$\mu_B = \sqrt{4S(S+1)}$$

when the orbital moment is fully quenched.

Since the ground state of the metallic ions in different valency states is generally known from spectroscopic data, susceptibility will be indicative of the valency of the colorant ions.

* In the equation, N is the Avogadro's number, B the Bohr magneton, K the Boltzmann's constant, T the absolute temperature, S the spin and L the orbital moments.

It is not known with certainty whether the glasses contain the colorants as free oxides or in chemical combination with the melts.

In the present work an attempt is made to determine whether the colorants are merely dispersed as oxides or exist in chemical combination with the melts and to find out magnetically the valency state of the colorant ions when thus dissolved or dispersed in easily fusible glasses. Borax glass has been selected because of its availability in the pure state and the simplicity of its preparation. In order to avoid complications arising from the negative radical, the pure oxides have been employed for imparting colours to glass.

Experimental

The coloration of borax glass by chromium, manganese, iron, nickel and cobalt has been studied under oxidizing and reducing conditions.

The glasses were prepared from extra pure sodium borate, which was fused in a platinum vessel at 750°-800° C. in an electric furnace till a transparent mass was obtained.

The coloured melts were prepared by fusing together the metal oxide and the borax glass to a clear liquid. The colour of the glass could be judged at any time by removing a small bead on platinum. The glass so formed was slowly cooled and pulverized in agate.

To obtain oxidizing conditions the melts were heated in an electric furnace in free access of air and reducing conditions were obtained by heating the glass with tartaric acid. The metal oxides were prepared from analytically pure metal salts and analysed before use. The methods adopted for the estimation of the colorants dissolved in glass were standardized by control experiments carried out in the presence of glass.

The concentration of the colorants was varied, only such concentrations being used which gave a convenient depth of colour.

The susceptibility determinations were carried out on a modified form of Gouy's balance and the calculation for mass susceptibility of the colorant ion was made by the help of the relationship:

$$X_a = X_c C_c + X_g (1 - C_c)$$

where X_a is the observed specific susceptibility of the coloured glass, X_c the susceptibility of the colorant ion, X_g of the borax glass and C_c the concentration of the colorant ion.

The borax glass gave a X -value of -0.421×10^{-6} at 20° C. and it was found that its susceptibility remained unchanged before and after heating the glass with tartaric acid, and hence its use as a reducing agent does not complicate matters in any way. The values of X_c thus calculated for different colorants were compared with values theoretically arrived at on Bose-Stoner formulæ.

According to Hund the effective Bohr magneton number is expressed by the relationship:

$$\mu_B = 2.839 \sqrt{X_M T}$$

The magnetic moment was calculated on the basis of Hund's expression and in order to correct for the deviations from the Curie Law, it became necessary to investigate the influence of temperature on the magnetic susceptibility of the colorants and thus to determine the value of the Curie temperature θ , and to calculate μ_B according to the formula:

$$\mu_B = 2.839 \sqrt{X_M (T - \theta)}$$

The values of magnetic moment so obtained were compared with the theoretically predicted values. The Curie temperature, θ , was found by plotting the $(\frac{1}{X}, T)$ graph and reading off θ as the intercept on the T -axis.

The experimental technique employed for the measurement of susceptibility at higher temperatures consisted in using an electrically heated silica tube-furnace which surrounded the susceptibility tube. The variations of temperature near the pole pieces on account of the proximity of the furnace were not found to affect the field strength, because the pull per gram observed for a standard diamagnetic at various temperatures was found to be unaffected. It was particularly found that X -value of the borax glass was independent of temperature between 293° and 550° K.

Manganese Glasses

Mellor⁸ states that manganese colours glass pink to violet under oxidizing conditions. The cause for the variation of tint with composition is not well understood⁹.

According to Thorpe¹⁰, the full colour is only developed when manganese is in a fully oxidized condition (Mn^{IV}).

Actually there has developed a fairly general opinion that the colour is due to trivalent manganese.

Fuwa¹¹ from his investigations concludes that manganic oxide is responsible for the pink colour and that manganese in colourless glass is divalent. He suggests that when MnO_2 is added to the melt there results a mixture of manganese dioxide, manganic oxide and manganous oxide and accordingly the exact tint is determined by the proportions in which they are present.

It is well known that borax bead containing manganese is pink-violet in the oxidizing and colourless in the reducing flame. The question all along has been the valency of manganese in the two forms.

Manganese dioxide was used as the colouring agent. It was prepared by heating analytically pure manganous nitrate at 155-160° C. for 50 hours. The black crystalline oxide so obtained was washed with water and dried at 200° C. under vacuum.

The glass was analysed for manganese content by the bismuthate method. Manganese was precipitated as dioxide from a known weight of the glass and dissolved in sulphuric acid and a little nitric acid. Sodium bismuthate was then added in order to oxidize the whole of manganese to per-

manganate and the permanganate was determined by titration.

The available oxygen was determined by adding a known excess of standard oxalic acid in the presence of dilute sulphuric acid to a known weight of the glass. The solution was heated to 70° C. and the excess of oxalic acid back titrated against standard permanganate. This estimation was made use of in calculating the amount of Mn^{+++} formed under oxidizing conditions.

The results of these estimations are given in Tables I and II which also record the susceptibility values.

The influence of temperature on the susceptibility of the decolorized glass is recorded in Table III.

For the decolorized glass the experimental value of X_c is in close agreement with the theoretical value for divalent manganese. The experimental value of μ_B is 5.99 and this again agrees remarkably well with the theoretical value of 5.91 for divalent manganese.

On exposure to ultra-violet light from a quartz mercury vapour lamp with a Wood filter, it was found that the decolorized glass gave an orange-red fluorescence resembling that obtained in the case of the anhydrous manganese halides¹², thereby lending further support to the view that

TABLE I. Coloured Manganese Glass.

Reading	Composition			$\chi_d \times 10^6$	$\chi_c \times 10^6$		
	Mn^{++} %	Mn^{+++} %	Total %		Exptl.	S only	Calc. for (S+L)
1	0.303	0.372	0.675	1.213	241.6	222.7	248.1
2	0.616	0.571	1.187	2.510	246.5	229.6	250.9

TABLE II. Decolorized Manganese Glass.

Reading	Composition			$\chi_d \times 10^6$	Temp. °C.	$X_c \times 10^6$	
	Mn^{+++} %	Mn^{++} %	Total %			Exptl.	Theory
1	0.000	0.814	0.814	1.750	20	269.3	269.4
2	0.000	1.187	1.187	2.780	25	266.3	265.4

TABLE III. Temperature and Susceptibility Relationship of Decolorized Manganese Glass.

Temp. °K.	$\chi \times 10^6$	θ	C_M	Mean C_M	μ_B
316	260.0		4.41		
355	233.2		4.45		
376	222.2	6.5°	4.51	4.48	5.99
430	193.5		4.49		
473	176.2		4.52		

manganese is divalent in this case. The glass gave no available oxygen, quite in conformity with the conclusions arrived at from the magnetic standpoint.

For the coloured glass, the observed X_c values lie in between the values calculated for S and for S+L. Table I (a) shows the contribution of Mn^{++} and Mn^{+++}

TABLE I (a).

Reading	Composition		$X_a \times 10^6$ at 20°	Contribution by		Mass susceptibility of Mn^{+++} calculated from 5
	Mn^{++} %	Mn^{+++} %		Mn^{++} $\times 10^6$	Mn^{+++} $\times 10^6$	
1	1	2	3	4	5	6
2	44.89	55.11	241.5	120.9	120.7	219.0×10^{-6}
	51.93	48.07	246.5	139.8	106.7	221.9×10^{-6}

to the observed X_c -values recorded in Table I.

Mn^{++} is in 6 *S* state and the *L* moment is fully quenched while Mn^{+++} is in 5*D* state and the *L*-moment may or may not be completely ineffective. It is clear from Table I that the *L* moment of Mn^{+++} is not fully quenched in the oxidized glass. This behaviour is in contrast with the observations of Johnson¹³ and Jackson¹⁴ who found that for trivalent manganese salts, the susceptibility values are very nearly the theoretical for "spin" only. It may be that Mn^{+++} ion is under the influence of an electric field of a particular symmetry type. The symmetry character will not depend simply on the symmetry character of the crystal but rather on the nature and arrangements of the ions and atoms in the immediate environment of the ion under consideration. That an aggregate of free ions acquires a magnetic moment when a field is applied is due to the change in the relative numbers of ions in, for example, the different *m*-states associated with a single *J*-state. If, however, those states are already widely separated by the action of an electric field initially present (the so-called crystalline field), a redistribution cannot so readily take place under the influence of a magnetic field and the susceptibility will be modified.

The normal action of magnetic field is to remove "degeneracy," that is to separate energetically states which have the same energy in the absence of the field. An electric field is primarily effective in removing the degeneracy associated with *L* moment, as shown by the Stark effect. It is possible, therefore, for the *L*-moment to be partially or wholly quenched by the action of a "crystalline field" while the *S*-moment remains practically unaffected.

The partial quenching of *L* moment in Mn^{+++} seems to be due to the influence of a crystalline field of this type. Theory predicts for trivalent manganese a susceptibility value (at 20°) of 184.6×10^{-6} when the

'*S*' moment alone is operative and a value of 230.8×10^{-6} when both orbital and spin moments are taken into consideration. The observed *X*-value of $220.5 \pm 1.5 \times 10^{-6}$ for Mn in the two cases that have been examined are in fair accord and it, therefore, appears that the colour of the oxidized manganese glass is due entirely to the presence in it of trivalent manganese.

The coloured samples did not show the type of fluorescence associated with the decolorized glass.

Iron Glasses

The colours ordinarily imparted to glass by iron oxide are green and yellow, the yellow corresponding to a higher state of oxidation. Heretofore the green colour has been quite generally attributed to ferrous oxide and the yellow colour to ferric oxide. The statement that green colour is caused by ferrous oxide is also made by Rogers¹⁵. He also mentions the decolorization of glass by the use of oxides of manganese which raises iron into the higher state of oxidation.

The most commonly used colorant in iron glasses is the oxide. This was prepared by precipitation of the hydroxide from an analytically pure ferric salt. The hydroxide so obtained was then dehydrated by heating it to 500° C. in an electric furnace.

Introduction of iron to the extent of 1-2 per cent. of the calculated net weight of the melt gave convenient depths of colour.

The method of analysis for ferrous and ferric iron was as follows:—

The glass was dissolved in hot dilute sulphuric acid and the solution made to a known bulk. An aliquot portion of it was immediately titrated against permanganate for ferrous iron; the other portion was reduced with a known weight of zinc and then titrated for total iron.

The ionic susceptibilities and other magnetic results are recorded in Table IV (a) and (b).

TABLE IV (a). Iron Glass in the Oxidized State.

Reading	Composition			$X_c \times 10^6$ at 20°C	$X_c \times 10^6$	
	Fe ⁺⁺ %	Fe ⁺⁺ %	Fe ⁺⁺ + Fe ⁺⁺⁺		Exp.	Calc.
1	1.189	0.00	1.189	2.704	262.4	264.5
2	1.024	0.00	1.024	2.317	266.9	264.5

TABLE IV (b). Iron Glass in the Reduced State.

Reading No.	Composition				$\times 10^6$		
	Fe ⁺⁺ %	Fe ⁺⁺ %	Fe ⁺⁺ + Fe ⁺⁺⁺ %	a	Exptl.	S only	Calc. for $S+L$
1	0.3369	.6821	1.0190	2.101	247.1	235.2	250.1
2	0.5240	.6648	1.1890	2.452	241.2	226.1	245.9

TABLE V. Temperature and Susceptibility Relationship of Oxidized Iron Glass.

Reading No.	Temp. °K	$X_c \times 10^6$	θ	C_M	Mean C_M	μ_B
1	289	262.4		4.20		
2	315	231.0		4.04		
3	359	202.3	2.5°	4.04	4.076	5.71
4	421	171.8		4.03		
5	470	155.4		4.07		

For the oxidized glass the susceptibility value of Fe ion for different samples was $264 \pm 3 \times 10^{-6}$ and the theoretical value for trivalent iron is in fair accord with it. The study of X_c -variations with temperature gave a θ value of 2.5° and a magnetic moment of 5.74. This value is in good accord with the theoretical value of 5.92 for trivalent iron on Van Vleck's formula for "spin" only. Hence the cause of the yellow colour in the oxidized iron glass is the presence in it of Fe⁺⁺⁺.

For the reduced iron glass, the observed X_c values fall between the values calculated for S and for $S+L$. Table IV (c) shows the contribution of Fe⁺⁺ and Fe⁺⁺⁺ to the observed X_c -values recorded in Table IV (b).

TABLE IV (c).

Reading No.	Composition		$X_c \times 10^6$ at 20°C	Contribution to X by		Mass susceptibility of Fe ⁺⁺ + calculated from (5)
	Fe ⁺⁺ %	Fe ⁺⁺⁺ %		Fe ⁺⁺ $\times 10^6$	Fe ⁺⁺⁺ $\times 10^6$	
1	33.06	66.94	247.1	175.7	71.4	216.0 $\times 10^{-6}$
2	44.07	55.93	241.2	146.8	94.4	214.2 $\times 10^{-6}$

Fe⁺⁺ is in 5D state and in conformity with the usual behaviour of ferrous salts, the orbital moment is not completely suppressed in this case. Theory predicts for divalent iron a susceptibility value of 179.9×10^{-6} when the S moment alone is operative and a value of 224.9×10^{-6} when both orbital and spin moments are taken into account.

The observed X_c -values of $215 \pm 1 \times 10^{-6}$ for Fe which are in fair accord, show that L moment is partially quenched in this case. The green colour of the reduced iron glass is inferentially due entirely to the presence in it of Fe⁺⁺.

Cobalt Glasses

Cobalt imparts a beautiful blue colour to glass. Though copper also colours glass blue, cobalt has been chiefly used. Cobalt glasses do not present different colorations in oxidizing and reducing atmospheres. With low concentrations of the colorant the glasses are quite transparent, but with high concentrations they become dull and darker in shade.

The colorant, cobalt oxide, was prepared by heating analytically pure cobalt nitrate. The oxide so obtained was washed with water till the filtrate gave no test for nitrate with diphenyl amine, and dried.

α -nitroso- β -naphthol was used for determining the percentage of cobalt in glass. The concentrations and the corresponding

specific susceptibilities are embodied in Table VI. Table VII shows the variations of X_c with temperature.

It is obvious that cobalt ion keeps the same valency state both under oxidizing and reducing conditions. The ionic susceptibility values of cobalt glass in both the states are very nearly the same.

Co^{++} is in the $4F$ state, the orbital moment is not fully quenched¹⁶ and hence the observed susceptibility values should lie intermediate between the values calculated on "spin only" and "spin and orbital combined." This is found actually to be the case thereby confirming the divalency of cobalt in the coloured glass.

This was further confirmed by a study of its variations with temperature, which give a μ_B value of 4.88, while theory predicts a value between 3.87 and 5.20 for bivalent cobalt.

Nickel Glasses

Nickel oxide imparts a brown colour to glasses under oxidizing conditions and the colour changes to grey and sometimes dark under reducing conditions. With low concentrations the glass in the oxidized condition is quite transparent and pinkish brown. The colour becomes dark and loses clearness when the quantity of nickel oxide is increased.

Nickel oxide, the colouring agent, was prepared in a similar manner to cobalt oxide by dry heating of the pure nickelous nitrate.

Nickel glass was analysed for nickel by dimethyl glyoxime method. The glass was dissolved in dilute hydrochloric acid and the metal was estimated as the dimethylglyoxime complex and the results of these determinations and also the corresponding susceptibility values are set forth in Table VIII. The effect of temperature on susceptibility is recorded in Table IX.

TABLE VI. Cobalt Glass Prepared Under Oxidizing Conditions.

Sample No.	Cobalt %	$X_a \times 10^6$ at 25°C	$X_c \times 10^6$		
			Exptl.	Calc. for S only	Calc. for S+L
1	0.390	0.2181	163.5		
2	0.650	0.6350	162.0		
3	1.285	1.6789	163.0	105.9	190.6
4	1.371	1.8190	163.0		

Cobalt Glass Prepared under Reducing Conditions.

5	1.580	2.171	163.6		
6	1.285	1.680	163.0		190.6
7	1.897	2.740	166.2		

TABLE VII. Ionic Susceptibility at Different Temperatures: Cobalt Glass.

No.	Temperature °K	$X_c \times 10^6$	θ	C_M	Mean C_M	μ_B
1	293.0	163.0		2.980		
2	312.0	152.5		2.958		
3	353.0	135.3	—17°	2.952	2.956	4.88
4	381.0	126.1		2.960		
5	415.0	116.1		2.958		
6	475.0	101.1		2.927		

TABLE VIII. Nickel Glass Prepared under Oxidizing Conditions.

Sample No.	Nickel %	$X_a \times 10^6$ at 25°C	$X_c \times 10^6$		
			Exptl.	Calc. for S only	Calc. for S+L
1	0.238	—0.1735	103.6		
2	0.433	0.0337	104.6	56.7	141.8
3	0.761	0.3970	107.1		
4	1.090	0.7281	105.0		

TABLE IX. Ionic Susceptibility of Nickel Glass at Different Temperatures.

No.	Temperature °K	$X_c \times 10^6$	θ	C_M	Mean C_M	μ_B
1	314.0	101.0		1.879		
2	354.0	89.56	—3.0°	1.876	1.876	3.89
3	394.0	80.47		1.875		
4	475.0	66.74		1.872		

The susceptibility of nickel ion in different specimens of glass with varied concentrations of the colorant is $105 \pm 2 \times 10^{-6}$. Ni^{++} is in the $3F$ state and hence the theoretical X-value of bivalent nickel for "spin only" is 56.7×10^{-6} and when the orbital moment is also operative, 141.8×10^{-6} . The experimental value falls between these two and hence shows that the colorant ion under oxidizing condition is in the bivalent state.

This is further confirmed by a study of the influence of temperature on the susceptibility of the glass. From the θ value, the Bohr magneton number comes to be 3.89. The theoretical value calculated for "spin only" is 2.83 and for "spin and orbital" moment 4.47.

The reduced glass was ferromagnetic due to the formation of metallic nickel.

Chromium Glasses

Chromium salts when heated with borax glass impart different shades of colour, varying from light yellow to green.

Chromic oxide, the colorant used, was prepared from analytically pure chromic anhydride, by reducing it with alcohol, precipitating the hydroxide and igniting it to oxide in an electric furnace.

Chromium glass contains Cr. in both stages of oxidation, and the production of pure chromate glass is difficult. Chromium glass prepared under reducing conditions does not contain any chromate which is more or less always present in the glass prepared under oxidizing conditions.

Total chromium in the glass was found by fusion with sodium peroxide and the

chromate thus formed was estimated by iodometric titration.

The free chromate was estimated by direct iodometric titration.

Table X records the results of these tests. The variations of X with temperature are shown in Table XI.

TABLE X. Chromium Glass Prepared under Reducing Conditions.

Sample No.	Cr. ⁺⁺⁺ %	CrO ₄ %	$X_a \times 10^6$ at 25°C.	$X_c \times 10^6$	
				Exptl.	Calc.
1	0.1629	0.0000	-0.2245	120.2	
2	0.1683	0.0000	-0.2181	120.1	120.3
3	0.2628	0.0000	-0.1041	120.1	

TABLE XI. Ionic Susceptibility of Reduced Chromium Glass at Different Temperatures.

No.	Temp. °K.	$X_c \times 10^6$	θ	C_M	Mean C_M	μ_B
1	298.0	120.1		1.949		
2	311.0	115.1		1.945		
3	351.0	101.7		1.930		
4	393.5	91.7	-14°	1.943	1.922	3.93
5	450.0	79.6		1.921		
6	479.0	74.6		1.912		

Under reducing conditions the chromium glass is bluish green and does not contain any chromate. The experimental value of ionic susceptibility is $120 \pm 0.2 \times 10^6$. The theoretical value of X_c for Cr^{+++} is 120.3×10^6 . This proves the trivalency of chromium in glass prepared under reducing conditions.

Bohr magneton value of 3.93 again agrees well with the theoretical value of 3.871 for Cr^{+++} .

In chromium glass prepared under oxidizing conditions, chromate was always present, but on account of the extremely small susceptibility differences indicated, no theoretical interpretation was possible.

In conclusion, it may be mentioned that the glasses do not contain the oxides in a finely dispersed state as was at one time believed, but the oxides exist in chemical combination with the borate glasses. The oxides have susceptibility values which deviate widely from the theoretically calculated values on Bose-Stoner formulæ, whereas the observed values are in fairly good accord with the theoretical deductions. Furthermore, even without correcting for θ and quite in conformity with the general behaviour of salts, and, unlike the oxides, the Curie point in the case of the colorant ions

has small values which will be clear from an examination of results embodied in the following table:—

TABLE XII

Name of glass	State	Curie point
Manganese	Reduced	+ 6.5
Iron	Oxidized	+ 2.5
Cobalt	Both	-17.0
Nickel	Oxidized	- 3.0
Chromium	Reduced	-14.0

Summary

In this work, the use of the magnetic method has been extended to the determination of the valency state of colorant ions when dissolved or dispersed in easily fusible glasses. The cause of the variations in tint which occur when changing from oxidizing to reducing conditions, has been investigated. It has thus been shown that whereas manganese in decolorized glass is in Mn^{++} state, the pink colour is due to trivalent manganese; oxidized iron glass contains the metal in trivalent state and the reduced glass in Fe^{++} and Fe^{+++} states; the blue colour of cobalt glass is due to Co^{++} ; the colour of nickel glass under oxidizing conditions is due to Ni^{++} whereas metallic nickel is formed under reducing conditions as shown by the appearance of ferromagnetism. Chromium presents both stages of oxidation and the production of pure chromate glass under oxidizing conditions is difficult.

References

- Berthelot, *Compt. Rend.*, 1906, **143**, 477; Simon, *Neues Jahrb. Mineral Geol. Beilage Band*, 1908, **26**, 249; Watson and Beard, *Proc. U.S. Nat. Museum*, 1917, **53**, 553.
- Wild and Liesegang, *Centralb. Mineral Geol.*, 1923, 737; Holden, *Am. Mineral*, 1925, **10**, 203; Koenigsberger, *Centralb. Mineral Geol.*, 1927, 15.
- Sir Herbert Jackson, *Nature*, 1927, **120**, 303.
- Van Vleck, *Theory of Electric and Magnetic susceptibilities*, Oxford, particularly Chapter XI, p. 73.
- Sommerfeld, *Atombau*, 4th Ed., p. 639.
- Bose, *Z. Physik*, 1927, **43**, 864.
- Stoner, *Phil. Mag.*, 1929, **8**, 250.
- Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, 1925, **6**, 52.
- Scholes, *J. Soc. Chem. Ind.*, 1916, **35**, 518.
- Thorpe, *Dictionary of applied Chemistry*, 1912, **2**, 721.
- Fuwa, *J. Japan Ceram. Assoc.*, 1923, **366**, 8097.
- Randall, J. T., *Trans. Faraday Soc.*, 1938, **35**, 12.
- Johnson, *Trans. Faraday Soc.*, 1932, **28**, 848.
- Jackson, *Proc. Physical Soc. (London)*, 1935, **47**, 1029.
- Rogers, *Manual of Industrial Chem.*, 1922, **3**, 387.
- Bhatnagar, Nevgi and Khanna, *Phil. Mag.*, 1938, **25**, 234.

DIELECTRIC CONSTANT AND POWER FACTOR OF INDIAN MICA

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MICA is one of the best insulating materials possessing high insulating properties, large dielectric constant and low power factor. These properties, together with the fact that it is a heat-resistant material available in thin flakes, makes it immensely useful in the electric and radio industry for a large variety of purposes, e.g., manufacture of motors, commutators, electric heaters, converters, spark plugs, radio condensers and radio valves.

The electrical properties of mica, especially its power factor, determine its suitability for radio or other electrical industry. The power factor of mica, available in different parts of the world, has been investigated by a large number of workers. Thus Lewis, Hall and Caldwell¹ carried out power factor measurements of a large number of samples of mica fairly representative of the major sources of world supply. Datta, Sen Gupta and Mahanti² have examined and reported on a fairly large number of Indian mica samples from different provinces of the country. More recently, Hall³ has carried out power factor measurements upon a large variety of samples available in the United States of America with a view to assessing their suitability for the manufacture of radio condensers.

India being the largest source of mica supply in the world, a precise knowledge of the electrical properties, especially the dielectric constant and power factor, of representative specimens from various parts of the country, is of profound interest. With this end in view, a large number of specimens, about 300 in all, from different sources obtained through the kind courtesy of the Central Mica Enquiry Committee, Government of India, have been investigated.

Occurrence and Mineralogical Description

There are eight varieties of mica known to the mineralogist; but only two of them, viz., muscovite or potassium mica [$\text{KH}_2\text{Al}_3(\text{SiO}_4)_3$], and phlogopite or magnesium

mica [$\text{KH}(\text{MgF})_3\text{Mg}_3(\text{AlSiO}_4)_3$], are used in the electrical and radio industries. The muscovite variety is mined principally in India and the phlogopite in Canada and Madagascar. Muscovite mica is also found in the United States of America, Russia, Norway and other countries. The mica samples examined by us were all of the muscovite variety. According to Messrs. Mica Insulator Company, the constituents of the two varieties are approximately as shown below:—

Experimental Procedure

The following test equipment was used

Variety	Silica %	Alumina %	Potash %	Magnesia %	Ferric oxide %	Water %
Muscovite	45.2	38.4	11.8			
Phlogopite	40.8	26.9	12.7	7.6	12.0	4.6

in the measurements of dielectric constant and power factor.

1. Capacity Bridge, *General Radio*, Type No. 216.
2. Direct-reading Standard Condenser, *General Radio*, Type No. 772.
3. Beat Frequency Oscillator, *RCA*, Type No. 154.

As the construction and use of these instruments are well known, it is not proposed to describe them here. The bridge employed consists of a pair of ratio arms, additional resistance together with a switch for changing its position from one arm to the other, and shielded input and output transformers. The ratio arms consist of equal resistances so arranged as to be perfectly symmetrical in construction with regard to all the other components. The bridge circuit is isolated from any extraneous pick-up by interposing balanced and shielded transformers between the bridge and power source, as also between the bridge and the null point detector. The remaining two arms of the bridge are formed by a shielded balancing air condenser in one

TABLE I. *Samples from Rajputana Mines*

No.	Source	Quality	Dielectric constant		Power factor	
			Mean value*	Range of variation	Mean value* $\times 10^4$	Range of variation $\times 10^4$
1	Benera Mines	Ruby, slightly stained	6.8	6.4—7.9	4.4	1.5—6.7
2	Harda Mines	Black, multi-coloured spots	8.2	6.6—9.7	5.7	3.0—7.0
3	Bharni Mines	Clear, slightly greenish	6.7	5.3—8.9	1.9	1.1—3.4
4	Potla Mines	Copper oxide spots	8.9	8.8—9.1	5.2	1.8—8.6
5	Baurali Mines	Dull, few spots	7.1	5.7—8.4	3.0	2.1—3.5
6	Sedris Mines	Smoky, no spots	6.8	5.9—8.4	2.7	1.6—2.8
7	Bhadu Mines	Pinkish, no spots	7.1	5.7—8.4	3.0	2.1—3.5
8	Bhilwara Mines (Mewar)	Slightly stained	7.1	4.1—7.5	5.1	3.1—8.8
9	Jhamauli Mines	Spotted, mineral inclusions	7.0	6.6—7.2	4.0	2.2—4.1
10	Amli Mines	Slightly pinkish	6.5	6.4—6.9	3.2	1.5—6.0
11	Gundli Mines	Clear	6.6	6.3—7.0	1.4	1.3—1.7
12	Bewara Mines	Clear	6.6	5.9—7.2	8.4	8.1—11.0

TABLE II. *Samples from Madras Mines*

1	Shah Mines (Syedapuram)	Black spots	6.9	6.7—6.97	5.9	2.1—8.2
2	Do.	Thin black spots	6.7	6.6—6.8	1.3	1.0—2.7
3	Do.	Thick black spots	8.3	7.3—9.3	5.5	4.3—5.6
4	Do.	Black stains	6.6	6.3—6.8	2.4	2.0—2.8
5	Do.	Metallic stains	6.5	6.1—6.7	5.4	2.9—9.0
6	Do.	Blackish stains	6.7	6.6—6.99	4.2	1.1—6.0
7	Gangupali Mines (Syedapuram)	Greenish	6.9	6.7—7.3	1.2	0.2—3.0
8	Kalichedu Mine	Slightly pink	6.2	5.2—6.9	4.1	2.3—7.4
9	Do.	Ruby, clear	6.8	6.6—7.1	2.2	0.8—3.0
10	†	Ruby, clear	6.5	6.2—6.7	1.2	0.7—2.2
11	Killy Mines	Greenish, clear	7.0	6.7—7.6	0.9	0.1—1.5

TABLE III. *Samples from Bihar Mines*

1	Dhale Mines	Ruby, clear	5.6	4.2—6.7	4.5	2.1—7.3
2	Do.	Do.	7.2	6.9—7.4	6.8	4.6—9.4
3	Do.	Slightly stained	7.3	7.1—7.5	8.9	7.1—9.8
4	Do.	Ruby, clear	7.0	6.7—7.4	6.9	5.6—8.6
5	Do.	Slightly stained	6.9	6.8—7.2	1.8	0.8—2.9
6	Do.	Highly stained	7.0	6.7—7.4	5.3	3.7—6.4
7	Demehhench Mines	Ruby, clear	5.2	5.0—5.8	3.0	2.4—3.2
8	Do.	Very slightly stained	6.7	6.6—6.8	1.1	1.7—2.4
9	Do.	Slightly stained	6.9	6.8—7.3	1.6	1.5—2.7
10	Do.	Air inclusions	3.6	3.0—4.3	6.2	4.7—8.4
11	Do.	Ruby, clear	6.8	6.7—7.1	8.0	7.0—8.8
12	Do.	Do.	7.0	6.8—7.2	1.7	0.9—2.5
13	Do.	Do.	7.0	6.9—7.2	3.0	2.7—3.8

* Mean of values for 5 to 8 samples.

† Supplied by the Chairman, Central Mica Enquiry Committee.

TABLE IV. *Samples from Bihar Mines*

No.	Source	Quality	Dielectric constant		Power factor	
			Mean value*	Range of variation	Mean value* $\times 10^4$	Range of variation $\times 10^4$
1 (a)	Bendi Mines (Hazari Bagh Mica Mining Company)	Ruby, block No. 4	4.9	3.6—6.0	5.5	3.7—9.0
(b)	Biragara Mine (N. K. Sahana & Sons).	Green, block No. 4	6.7	6.4—7.2	13.0	8.4—20.0
2 (a)	Garka Mine (R. K. Sahana & Sons).	Ruby, block No. 4	6.7	5.9—7.4	7.9	5.9—8.9
(b)	Bongada Mine (Mr. N. D. Mitter).	Bottle green, block No. 4	6.3	6.0—6.5	6.9	5.4—9.5
3 (a)	Gidhawana Mine (S. K. Sahana & Sons).	Green, block No. 5	6.5	6.1—6.7	6.3	3.6—9.1
(b)	Sq. No. 6(a) (B. N. Daw & Sons).	Ruby, block No. 5	6.7	6.5—6.9	10.0	6.3—20.0
4 (a)	Salaidin Mine (B. N. Daw & Sons).	Green, block No. 5	5.6	4.1—7.5	17.0	9.3—29.0
(b)	Lonchanchi Mine (Mr. G. Samante).	Ruby, block No. 5	6.9	6.7—7.2	8.1	4.7—14.0
5 (a)	Aurvantan Mine (Parsabad Area).	Dark green, block No. 4	7.1	6.7—7.2	7.8	5.2—8.8

* Mean of values for 5 to 8 samples.

TABLE V. *Samples from Madras Mines*

No.	Source	Quality	Dielectric constant		Power factor	
			Mean value*	Range of variation	Mean value* × 10 ⁴	Range of variation × 10 ⁴
1 (a)	Ramji Mines (Turikerla)	Ruby	6.7	6.6—6.9	12.0	7.9—19.0
(b)	Venkatapakahmi Mine (Chennur)	Green	6.1	5.8—6.2	5.7	5.0—9.3
2 (a)	Sitharama Mine (Thurimerla)	Ruby	6.7	5.9—7.4	8.0	5.9—8.9
(b)	Rustohrem Mine (Tatiparthy)	Green	6.3	5.9—6.7	4.4	1.3—8.1
3	Sreemanjanya Mine (Degapudi)	Green	6.6	6.4—6.9	4.6	3.9—6.9
4 (a)	Pattabirama Mine (Turimerla)	Ruby	6.3	5.1—6.8	3.4	1.3—6.1
(b)	Harnath Gopal Mine (Chenganapalli)	Green	6.6	6.1—7.2	6.4	4.5—8.8
5 (a)	Kalayanarama Mine (Kallechedu)	Ruby	7.1	6.6—7.7	14.0	8.0—39.0
(b)	Dallamani Mine (Changanam Utakar)	Green	6.5	6.2—6.7	5.3	4.6—8.3
6	Menakshi Sundram (Utakar)	Green	6.5	6.2—6.8	5.3	4.6—8.3
7	Sitarama Anjaneya Lakshmi	Green	6.4	6.3—6.4	3.5	2.1—4.4

TABLE VI. *Samples from Rajputana Mines*

1 (a)	Gadi Thorian Mine (Beaver Area)	Ruby	6.5	6.3—6.7	9.1	6.2—12.0
(b)	Kalyanipura Mine (Nasrabad Area)	Green	6.5	6.3—6.6	6.7	6.2—7.4
2 (a)	Bira Mines (Kekri)	Ruby	7.0	7.0—7.1	17.4	9.9—25.0
(b)	Jaipur Mines	Green	6.4	6.3—6.4	8.3	7.8—8.8
3 (a)	Tonk	Ruby	6.8	6.7—7.0	8.8	7.3—10.0
(b)		Green	6.6	6.6—6.7	6.4	6.0—6.9
4 (a)	Agrekhira	Ruby	6.2	6.0—6.3	3.0	2.7—4.1
(b)	Jhamali Mines (East Mewar)	Green	6.2	6.1—6.4	14.0	11.0—17.0
5	Dhikani Mines (West Mewar)	Ruby	6.2	6.2—6.3	6.4	6.0—8.4
6	Bharni Mine Kachhola (West Mewar)	Green	6.0	5.8—6.3	3.6	3.4—3.8

*Mean of values for 5 to 8 samples.

arm and the standard and unknown condenser (formed by using the mica specimen under test as dielectric) in the other. The beat frequency oscillator was employed as a source of 1,000 cycle signal, while for detecting the null point a pair of head phones was used in conjunction with an amplifier for greater accuracy.

The samples under test were cleaned and dried, and then inserted between two mercury electrodes to constitute the experimental condenser. Clear samples, free from air inclusions, were employed. Those having a thickness less than 2 mils, were rejected to minimize the effect of contact resistance. The capacity and the equivalent resistance of the experimental condenser were measured by the substitution method.

The dielectric constant K of mica was derived from the following relationship:—

$$K = C_x / C_a \quad (1)$$

where C_x is the capacity of the condenser and C_a the capacity of an equivalent air

condenser which is given by the relation:—

$$C_a = \frac{0.06954 D^2}{t} \quad (2)$$

where D is the diameter of the electrode in cms. and t the thickness of the material in cms.

The equivalent resistance R_x of the condenser is given by the following equation:—

$$R_x = \frac{(R^1 - R) C_x^2}{C_x^2} \quad (3)$$

where $(R^1 - R)$ represents the change in value of the added resistance when the experimental condenser is removed from the bridge and C_x is the total capacity of the standard condenser when the experimental condenser has been removed.

The power factor $P_f = R_x 2 \pi f C_x$ (4) where f is the frequency of the e.m.f. used.

Experimental Results

Tables I, II, and III give the results obtained. The names of the mines from which the samples were taken and the quality of the samples as judged by the appearance are also mentioned.

There is some prejudice in the trade against green mica; only ruby mica is considered to be suitable for the radio and electrical industry. The *Central Mica Enquiry Committee*, sent us several samples of ruby and green mica from different mines in Rajputana, Bihar and Madras for examination. The results obtained with these specimens are given in Tables IV, V and VI.

From the results obtained, it would appear that green mica is as good as ruby mica in dielectric and power factor values at the frequency employed in this investigation, and the prejudice against green mica appears to be unjustified.

Discussion

From Tables I, II and III it is evident that a fairly large number of samples possess high dielectric constant as well as low power factor. According to the *Bureau of Mines Circular*⁶, good condenser mica should have a power factor not in excess of 3.0×10^4 . Judging from this criterion, most of the samples tested by us are good enough for the purpose of manufacturing radio condensers. But there are a few more factors to be considered. The suitability of mica for condenser insulation varies according to the service for which the condenser is to be designed. For high voltage work, especially in radio transmitters and power generators, mica of the highest insulation and electric strength is required. In the manufacture of precision standard condensers, the variation of dielectric constant and power factor with temperature and humidity has to be taken into consideration.

Even spotted and slightly stained mica samples are tolerably good, although they cannot be used for high class work. The values of power factor of the samples examined by us cannot be compared with those of other workers, as the nature and amount of spots and stains vary from sample to sample. The values of ruby and green clear micas obtained by us agree fairly well with those of other workers. According to

Spry⁴ the power factor of muscovite mica varies from 1.0 to 8.0×10^{-4} at 25° C. for a frequency range of 60 to 1000 kcs./sec. Lewis, Hall and Caldwell¹ found that the power factor of clear Indian ruby mica varies from 1.0 to 2.0×10^{-4} . Datta, Sen Gupta and Mahanti² have also obtained similar results. Our results are in closer agreement with those of Spry⁴. The limited range of variation as observed by Hall and others is, however, applicable to only selected grades of mica of good quality as stated by them. Not much work seems to have been done on the variation of power factor with temperature, humidity and frequency. Donnatt and Goodall have found that clear ruby mica possesses outstanding superiority over the other varieties as regards the variation of power factor with temperature and frequency. Hall has observed that some varieties of mica have got a higher power factor at 100 kcs./sec. than at 1000 kcs./sec., some samples showing a ratio of 5 : 1 at these frequencies. Donnatt and Goodall find that in the case of ruby mica the power factor is very much the same at 60 and 800 cycles/sec. As mentioned earlier, mica finds use in a variety of radio and electrical components and hence an exhaustive study of the variation of its electrical properties with temperature, humidity, and frequency is very desirable in order to determine its exact usefulness in the industry.

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References

- ¹ Lewis, Hall and Caldwell, *B. S. J. R.*, 1931, 7, 403.
- ² Datta, Sen Gupta and Mahanti, *Ind. J. Phys.*, 1943, 26, 79.
- ³ Hall, *P. I. R. E.*, 1944, 32, 393.
- ⁴ Spry, *Ele. Eng.*, 1939, 287.
- ⁵ Donnatt and Goodall, *J. I. E. E.*, 1930, 69, 490.
- ⁶ Lawrence G. Houk, *Bureau of Mines Information Circular, Marketing Strategic Mica*, I. C. 7219, September, 1942.

STUDIES IN INDUSTRIAL MICRO-ORGANISMS

PART I—NUTRITIONAL REQUIREMENTS OF SOME LACTIC MICRO-ORGANISMS

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DAVIS¹ and collaborators were the first to show that lactic organisms isolated from red spots of cheddar cheese require accessory growth factors in addition to carbohydrates and proteins. At that time it was difficult to identify accessory growth factors, as culture media and the technique were not sufficiently refined. However, the factor required by the organism was shown to be associated with concentrates of thiamin which by itself was found to be inactive; it was, therefore, concluded that the essential factor occurred as an impurity in the concentrate.

Eight years later, accessory growth factors essential for lactic acid bacteria were definitely established to be vitaminic in nature by a number of investigators²⁻⁵. Investigations of Orla-Jensen⁶⁻¹⁰ and collaborators and Eagles¹¹ and co-workers were responsible for stimulating considerable interest in a study of the nature, distribution and function of accessory growth factors in addition to suitable sources of carbon, nitrogen and minerals. The finding of Orla-Jensen⁶ *et al.* that riboflavin was required by lactic acid bacteria was confirmed by several workers¹²⁻¹⁵ with respect to other strains of lactic organisms. This opened a new field in vitamin research and laid the foundation of the microbiological assay of riboflavin by Snell and Strong¹⁶. A study of the riboflavin requirements of lactic acid bacteria¹⁷ by the same authors showed that seven out of the eleven species tested did not require this vitamin. Snell¹² and collaborators studied the nutritional requirements of *Leuconostoc mesenteroides* P-60. They later showed that pantothenic acid^{18, 19}, tryptophane²⁰ and purines^{21, 22}, but not riboflavin^{17, 23}, were essential for the organism. Recently Campbell and Hucker²⁴ have investigated the riboflavin requirements of lactic acid bacteria.

Several growth factors for lactic acid bacteria besides riboflavin have been identified by Snell^{25, 12} *et al.* and by other investigators^{26, 4} in the course of partially successful attempts to fractionate the complex media. Snell^{18, 27} and co-workers showed

that *Lactobacillus helveticus* and *Lactobacillus arabinosus* were greatly stimulated by nicotinic acid. An improvement in growth due to nicotinic acid was also reported by Möller²⁸ and Orla-Jensen²⁹ *et al.* In the nutrition of *L. arabinosus* and other micro-organisms. Bovarnic³⁰ showed that nicotinamide could be completely replaced by a heated mixture of asparagin and glutamic acid. Krehl and Strong³¹ reported a precursor of nicotinic acid present in extracts of wheat bran and certain other biological materials which on mild alkali treatment was capable of stimulating the growth of *L. arabinosus*. Pantothenic acid was also shown to be an essential nutriment for the same organism by Snell and Wright³². The role of pyridoxine as a growth factor for several species of lactic acid bacteria was indicated by the positive findings of Möller³³⁻³⁵. Bohonos^{36, 37} *et al.* have shown that pyridoxine stimulates the growth of *L. mesenteroides* P-60. Pseudopyridoxine was shown by Carpenter³⁸ *et al.* and Snell³⁹ and collaborators to enhance the activity of *S. lactis*. Recently microbiological differentiation of pyridoxine and pseudopyridoxine has been reported by Connor-Johnson⁴⁰. In presence of both compounds the yeast, *Saccharomyces carlsbergensis* has equal affinity for both, whereas *L. casei* and *L. lactis* *R* utilise pseudopyridoxine from the mixture. Evidence for the production *in vivo* from pyridoxine of compounds with increased activity for certain lactic acid bacteria³⁹ and for the production of similar compounds by amination or oxidation *in vitro* has been reported. Of these few, pyridoxamine and pyridoxal were identified as the active compounds³⁶. The activity of these compounds in promoting the growth of a number of different organisms has been compared with that of pyridoxine by Snell³⁷ *et al.* and a differential assay method has been recently described by Snell³⁸ employing *L. casei*, *S. faecalis* and *S. carlsbergensis* by means of which substances present in natural materials which promote the growth of these organisms on appropriate vitamin B₆ free media were classified into three fractions

which resemble pyridoxal, pyridoxamine or pyridoxine in growth-promoting properties.

In addition to riboflavin, niacin, pyridoxine and pantothenic acid, there are other substances in extracts of liver, yeast and other natural materials which are required for growth. Snell and Peterson⁴¹ studied two such substances acting upon *L. helveticus* one of which Stokstad⁴² identified as folic acid. Biotin concentrates and a thermolabile substance present in malt sprouts have been reported by Möller²⁸ and Pan⁴³ and co-workers to stimulate the growth of lactic acid bacteria. *p*-Aminobenzoic acid was shown to be an essential factor for *L. arabinosus* by Lewis⁴⁴. An unknown substance present in rice polishings was observed by Clarke⁴⁵ *et al.* to greatly stimulate the growth of *L. casei*; this finding was later confirmed by Wegner⁴⁶ and collaborators. An enzymatic digest of vitamin-free casein together with *dl*-alanine was very recently reported by Snell⁴⁵ to contain a substance which permitted the growth of *L. casei* in the absence of vitamin B₆. In contrast to vitamin B₆ this substance is not destroyed by light and is not readily adsorbed from aqueous solutions by charcoal. A factor present in mammalian bloods was reported by Feeney and Strong⁴⁷ to stimulate the growth of *L. casei* ξ . Light and Clarke⁴⁸ in their studies relating to the use of *L. casei* in microbiological assays have investigated the nutritional and vitaminic requirements of the organism. An unknown substance present in yeast extract required by certain strains of *S. lactis* was reported by Smith⁴⁹. A factor contained in natural extracts which stimulated the early growth of *L. casei* was reported by Pollack and Linder⁵⁰. The growth factors required by *L. casei* and *L. casei* ξ have been studied by Dolby⁵¹ and co-workers. The peptone factor was found to be a multiple factor by Ju-Hwa Chu⁵² *et al.* consisting of *p*-aminobenzoic acid, amino acids, peptides and a material with vitamin B₆ activity. In a recent paper on the nutrition of *Streptococcus lacticus*, Niven⁵³ has studied the vitaminic and amino acid requirements of the organism. The growth requirements of *L. mesenteroides* strain 535 was studied by Gaines⁵⁴. Luckey and Briggs⁵⁵ in their studies relating to the use of *S. lactis* *R* in microbiological assay, have thoroughly investigated the vitaminic, mineral and other nutrient requirements of the organism. The essential nature of the potassium ion for plant life has been known

for some time. Recently it was shown by Rogosa⁵⁶ that the growth, acid production and pH. change by *L. casei* respond quantitatively to increasing concentrations of potassium. Folic acid was found to be an essential factor for *S. lactis* *R* by Mitchell⁵⁷ *et al.* The identity of "*L. casei* factor," the norit eluate factor, the "*Streptococcus lactis* *R* factor" and vitamin B₉ with folic acid was reported by Pliffler⁵⁸ and collaborators. However, investigations by Stokstad⁴² and Keresztesy⁵⁹ and collaborators give conflicting reports about the identity of SLR factor with *L. casei* factor. Folic acid preparations from liver were found to be effective for both the organisms whereas the SLR factor was found to be ineffective for *L. casei*. Recently Hutchings⁶⁰ and collaborators isolated the *L. casei* factor, a crystalline compound active for *L. casei* as well as *S. lactis* *R*. More recently Binkley⁹³ *et al.* reported that crystalline compounds isolated from liver and from yeast have equal potencies for *L. casei* and *L. faecalis*. The compound from yeast was obtained from a concentrate of a conjugate which had no activity for either organism but had full activity for both organisms after enzymatic digestion. Krueger⁹⁴ *et al.* report identical growth response of *L. casei* and *Streptococcus faecalis* to vitamin B₉ prepared from liver and from yeast. In 1935 it was reported by Day⁶¹ and collaborators that monkeys which were given a diet consisting of refined foodstuffs developed a syndrome characterized by anæmia, diarrhoea, etc., and the term vitamin M was proposed by Langston⁶² and co-workers for the unknown factor responsible for the disease. The subject has been recently reviewed by Day⁶³. Very recently Day⁶⁴ and collaborators have reported the identity of "*L. casei* factor" with vitamin M. The potency of a highly purified preparation of the *L. casei* factor was tested in three monkeys rendered cytopenic with successful results.

A complete list of the amino acids required by lactic acid bacteria has been compiled by Möller⁶⁵. In an earlier paper Möller²⁸ studied the amino acid requirements of *Streptobacterium plantarum* and found glutamic acid, aspartic acid, leucine and valine essential for the organism. The growth was further improved by cystine and a few other amino acids. The beneficial influence of cystine for lactic acid bacteria was also reported by Hunter²⁶. Orla-Jensen⁶⁶,

showed glutamic acid, aspartic acid, leucine, valine, isoleucine and methionine as indispensable for *Streptobacterium plantarum* strain 10S. Cystine, tryptophane, alanine and phenylalanine were utilized with variable effects. The growth factors required by *L. arabinosus* have been studied by several investigators^{32, 44, 67}. Glutamic acid has been reported by Pollack and Linder⁶⁸, Shankman⁶⁹⁻⁷⁰, Hegsted⁷¹, Hutchings⁷² *et al.* and others⁷³⁻⁷⁴ to be an essential nutrient for the organism. Pollack and Linder⁶⁸ have reported that glutamine and glutamic acid have equal growth promoting activity for the organism. The relationship of glutamine and glutamic acid has been recently studied by Lyman⁷⁵ and collaborators. The activity of other related compounds, viz., α -ketoglutaric acid, β -hydroxyglutaric acid and pyrrolidonecarboxylic acid were also investigated; the former was found to be active under certain conditions whereas the latter two were observed to be completely inactive. Tests on the specificity of the organism for glutamic acid showed that glutamine is very active. It has been established by a number of workers that only the naturally occurring enantiomorph of leucine⁷⁴, isoleucine⁷⁴, valine^{74, 71}, tryptophane⁷⁶, glutamic acid⁷³ and lysine⁷³ was utilized by *L. arabinosus*; likewise for *L. casei*, only the *l*- or natural form of valine was found active⁷⁷. In a recent paper on the utilization of amino acid enantiomorphs, Stokes and Guinness⁷⁸ observed that *L. arabinosus* was unable to utilize the *d*-forms of threonine and methionine and *L. casei* the *d*-forms of phenylalanine, leucine, arginine, tryptophane and tyrosine. In the nutrition of *L. arabinosus*, Shankman⁶⁹ has shown cystine, methionine, valine, leucine, isoleucine, threonine, tryptophane and glutamic acid to be essential. Kuiken^{73, 74} and collaborators have compiled a list of the amino acid requirements of the organism. Recently Hegsted^{71, 92} has thoroughly investigated the amino acid requirements of *L. arabinosus*. The single omission of arginine, cystine, glutamic acid, leucine, isoleucine, methionine, phenylalanine, tryptophane, tyrosine or valine from the medium containing 19 amino acids prevents growth of the organism. However, a mixture of these ten amino acids is not adequate for growth, threonine, lysine and aspartic acid being required in addition. Isoleucine was confirmed by McMahan⁷⁷ to be essential for the organism. Wooley and

Sebrell⁷⁹ also confirmed tryptophane as an essential amino acid for *L. arabinosus*. Three species of heterofermentative lactic acid bacteria were studied by Wood⁸⁰ and collaborators and data are available for *L. casei*⁷² and *Streptococcus lactis* R⁸¹. *L. casei* was reported by Hutchings and Peterson⁷² to grow on glycine or alanine whereas *S. lactis* R was observed by Snell and Guirard⁸¹ to require both of them for growth. Asparagin was shown to stimulate the growth of *L. casei* and other lactic acid bacteria^{82, 68}. Feeney⁸² *et al.* showed that its effect could be duplicated by glutamic acid. In a recent paper Dunn⁸³ and collaborators have investigated the amino acid requirements of *L. mesenteroides* P-60. Seventeen of the twenty-one amino acids employed were found essential for growth, alanine, hydroxyproline, norleucine and norvaline were found non-essential or auxiliary growth substances. Feeney and Strong⁸² and Pollack and Linder⁶⁸ observed that lactic acid bacteria may be stimulated or inhibited by amino acid mixtures, but it is not possible to ascribe the effects to any one particular component. Fox⁸⁴ and collaborators reported the inhibition of *L. arabinosus* by *d*-leucine in concentrations of 50 mg. in 2.5 ml. in a basic complete medium. Snell and Guirard⁸¹ observed that pyridoxine could be effectively replaced by alanine for the growth of *S. lactis* indicating the possible synthesis of the vitamin, from this amino acid. A consideration of the structural relationships of the two would reveal that this amino acid may be the biological precursor of the vitamin. Recently the effect of alanine on the response of *L. casei* to pyridoxine and folic acid has been reported by Snell⁸⁵. More recently Snell⁹⁵ conclusively showed that alanine can completely replace vitamin B₆ in the nutrition of *S. faecalis* R (*S. lactis* R). In presence of an enzymatic digest of vitamin-free casein, *d* (-) alanine was observed to promote the growth of *L. casei* in a vitamin B₆ free medium where as *l* (+) alanine was found to be inactive. Both the optical forms of alanine were required for the growth of these organisms in the absence of vitamin B₆, each serving different functions within the organism.

Since the observation of Richardson⁸⁶ in 1936 that uracil was essential for the growth of *Staphylococcus aureus* under certain conditions a large number of reports have appeared dealing with the requirements of

micro-organisms for purines and pyrimidine bases. Möller²⁸ showed that adenine was required for the growth of *Streptobacterium plantarum*. Snell and Mitchell⁸⁷ in their study of the growth requirements of lactic acid bacteria observed that under certain conditions each of the purine or pyrimidine bases of nucleic acid could become the limiting factor for growth. Adenine was observed to stimulate the growth of *L. arabinosus* and *L. pentosus* and was essential for the growth of *S. lactis* as was also thymine. Uracil was helpful for the growth of *L. arabinosus* and *L. mesenteroides* but guanine was essential for the latter organism. Similarly, although the compound obtained from solubilized liver by Stokstad⁸⁸ was more active in providing for the growth of *L. casei*, it could be replaced by guanine, adenine, hypoxanthine, xanthine and thymine but not by uracil or cytosine. In the nutrition of *L. casei*, Krueger⁹⁴ *et al.* reported the complete replacement of vitamin B by thymine whereas in the nutrition of *S. faecalis* it had no effect. Feeney and Strong⁸² have shown that the yeast extract required for the growth of *L. casei* could be replaced by a mixture of known compounds including adenine and guanine. While studying the growth stimulation of *L. casei* by pyrimidines, Chattaway⁸⁹ observed that orotic acid (uracil 4-carboxylic acid) was the only compound found to stimulate the activity of the organism. In a recent paper Stokes⁹⁰ reported that thymine or thymidine in a concentration of 5,000 times could substitute folic acid in the growth of *S. lacticus* R and related streptococci. Adenine was found to be necessary for the maximum growth of *S. lacticus* together with thymine or folic acid. Guanine or xanthine could substitute adenine but was less effective.

The present work is a study of the nutritional requirements of ten strains of lactic acid organisms with special reference to a few forms of nitrogen and accessory growth factors.

Test Organisms and Preparation of the Inoculum

The following pure cultures were studied: L.C.-2, N.C.T.C.: 2077; L.C.-3, N.C.T.C.: 2078; L.C.-4, N.C.T.C.: 2079; L.C.-5, N.C.T.C.: 2080; L.C.-6, N.C.T.C.: 2081; L.C.-9, N.C.T.C.: 2084; L.C.-10, N.C.T.C.: 2085; *Streptococcus lactis*, N.C.T.C.: 2086; *Lactobacillus acidophilus*, N.C.T.C.: 2087 and *Lactobacillus bulgaricus*, N.C.T.C.:

2088. The cultures were obtained from the National Collection of Type Culture, India, Indian Institute of Science, Bangalore.

Stab cultures of the organisms were carried in liver extract—peptone-glucose-agar (3 cc./100 cc., 0.5%, 1.0%, 1.5% respectively). The method of preparing and carrying cultures were those described by Snell and Strong¹⁶.

The inoculum was prepared by transfer from the stock culture to a sterile tube of basal medium to which sheep liver extract was added (3 cc./100 cc.). It was incubated at 37° C. for 24-36 hours before use.

Culture Media

Preliminary experiments were carried out on rather undefined media. Medium-1 consisted of peptonised Klim milk, whereas medium-2 was fortified with crystalline vitamin of the B complex, viz., thiamin, riboflavin, niacin, calcium pantothenate, and pyridoxine, each 1γ for 10 cc. medium. Media-3 and 4 consisted of whey prepared from Klim milk powder and fresh cow's milk respectively. Medium 5 was identical with Snell and Strong's¹⁶ basal medium but without yeast extract and with 0.1γ riboflavin for 10 cc. medium. In these studies only three cultures, N.C.T.C.: 2086-2088, were employed.

The growth of the organisms was observed in medium-6 consisting of 1 per cent. glucose nutrient broth. A modified medium of Stern and Frazier⁹¹ was also tried. The composition of medium-7, is given in Table I.

A systematic study was next made with different more or less synthetic media to elucidate the nitrogen and accessory growth requirements of the organisms. The compositions of different media are given in Table I.

The constituents of different media were prepared and preserved as follows:

Peptonised milk.—Klim whole milk powder (50 gms.) was dissolved in 500 cc. of water, skimmed and digested at pH. 5.5 with activated papain (2 gms.) at 40° C. for 48 hours. The digest was filtered, pH. of the filtrate adjusted to 7.0 with 10 per cent. sodium hydroxide, the precipitate filtered off and the filtrate made up to 500 cc. with water. It was preserved under toluene:

100 cc. of the filtrate contained:

total solids	4.126 gms.
total reducing sugars ..	1.933 gms.
total nitrogen	0.151 gms.
amino nitrogen	0.032 gms.
complexity, total N/amino N	4.73

The digest was finally adjusted to contain 1 per cent. reducing sugars.

Whey.—Klim whole milk powder (50 gms.) was dissolved in 500 ml. of water, skimmed, pH. adjusted to 4.5 with acetic acid and the precipitated casein filtered off. The pH. of the filtrate was carefully readjusted to 7.0 with 10 per cent. sodium hydroxide and the volume made up to 500 cc. with water.

100 cc. of the filtrate contained:

total solids	2.300 gms.
total reducing sugars	1.619 gms.
total nitrogen	0.037 gms.
amino nitrogen	0.009 gms.
complexity, total N/amino N	4.1

Whey from fresh cow's milk was prepared in a similar manner.

100 cc. of the filtrate contained:

total solids	4.400 gms.
total reducing sugars	2.850 gms.
total nitrogen	0.157 gms.
amino nitrogen	0.084 gms.
complexity, total N/amino N	1.89

In each case the volume was finally adjusted to contain 1 per cent. reducing sugars. They were preserved under toluene.

Carrot extract.—Fresh carrot mash (2½ kgs.) was treated with 5 l. of water, cooked at 5 lbs. pressure for 3 hours, filtered, filtrate clarified with egg albumin and concentrated to 200 cc. under reduced pressure. The pH. of the extract was adjusted to 7.0 with 10 per cent. sodium hydroxide and filtered. The extract was distributed into 10 cc. ampoules which were sealed, sterilized at 15 lbs. pressure for 20 minutes and stored in a refrigerator. Total solids=0.345 gms.; 1 cc. of extract=12.33 gms. of fresh carrots.

Liver extract.—Fresh minced sheep liver (100 gms.) was autolysed under toluene for 48 hours at 30° C. The autolysate was diluted to 100 cc. with water and the mash digested at pH. 5.5 with activated papain (5 gms.) at 40° C. for 48 hours. The digest was filtered, pH. of the filtrate adjusted to 4.5 with acetic acid, steamed for an hour and the precipitate filtered off. The pH. of the filtrate was carefully readjusted to 7.0 with 10 per cent. sodium hydroxide and filtered. The extract was concentrated to 60 cc. under reduced pressure and distributed into 10 cc. ampoules which after sealing were sterilized at 15 lbs. pressure for 20 minutes. They were stored in a refrigerator. Total solids=0.0330 gms./cc.; 1 cc. of extract=1.69 gms. of fresh liver.

Yeast extract.—Consequent to a study of the B-complex content of a number of yeasts in the National Collection, a strain rich in B-vitamins was selected for the preparation of the extract. The selected strain was grown in wort and a crop of about 200 gms. wet yeast was obtained.

Dry yeast (50 gms.) was autolysed under toluene for 48 hours at 30° C. The autolysate was diluted to 500 cc. with water and steamed for 2 hours. The mash was filtered. pH. of the filtrate adjusted to 7.0 with 10 per cent. sodium hydroxide, filtered and the extract sterilized at 15 lbs. pressure for 20 minutes. It was stored in a refrigerator. 1 cc. of this preparation was equivalent to 100 mg. of the original dry yeast. Total solids=0.038 gms./cc.

Acid-hydrolysed casein.—Fat and vitamin-free *B.D.H.* casein (50 gms.) was hydrolysed with 250 cc. of 25 per cent. H_2SO_4 . The mixture was autoclaved at 15 lbs. pressure for 10 hours. SO_4 -ions were removed with $\text{Ba}(\text{OH})_2$ and any excess of Ba-ion was carefully removed with the minimum amount of H_2SO_4 . The solution was adjusted to contain 100 mg. of dry matter per cc. It was distributed into 10 cc. ampoules which after sealing were sterilized at 15 lbs. pressure for 20 minutes. Traces of vitamins were effectively removed from the hydrolysate with 10 mg./cc. of Norit at pH. 3.0.

***l*-cystine, *l*-tryptophane and *l*-tyrosine.**—Stock solutions of *l*-cystine, *l*-tryptophane and *l*-tyrosine hydrochloride containing 1 mg./cc. were prepared and kept under toluene.

Asparagine.—A solution of asparagine containing 5 mg./cc. was prepared in water and kept under toluene.

Thiamin, niacin, pyridoxin and calcium pantothenate.—Stock solutions were prepared containing 100 γ/cc. dissolved in water and kept under toluene in the refrigerator.

Inositol.—Stock solution containing 1 mg./cc. was prepared in water and kept under toluene in the refrigerator.

Riboflavin.—A solution of riboflavin containing 100 γ/cc. was prepared in 0.02 N. acetic acid and kept under toluene in the refrigerator.

Inorganic salts.—Solution A contains 25 gms. of KH_2PO_4 and 25 gms. of K_2HPO_4 dissolved in 250 cc. of water.

Solution B contains 10 gms. of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 0.5 of NaCl, 0.5 gms. of FeSO_4 .

TABLE I. For 100 cc. of basal medium

[illegible]

* Peptonised milk supplied the necessary 1 per cent. carbohydrate.

TABLE II. Results expressed as cc. of 0.1 N. acid produced for 10 cc. of medium

Culture	Description	Medium (M)																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
<i>LC-2</i>																							
<i>NCTC-2077</i>	Rods					5.7	8.4	9.6	9.5	9.7	2.3	9.2	3.6	8.9	9.3	2.3	2.5	9.5	9.5	3.4	4.5	30.2	
<i>LC-3</i>																							
<i>NCTC-2078</i>	Rods					5.4	9.5	9.6	9.5	9.7	2.4	9.2	4.1	8.9	9.4	1.2	2.3	9.5	9.6	4.0	4.7	30.2	
<i>LC-4</i>																							
<i>NCTC-2079</i>	Rods					6.2	8.5	7.4	7.3	8.4	7.5	7.9	7.8	7.7	8.1	5.2	7.0	8.3	8.3	8.5	8.4	26.4	
<i>LC-5</i>																							
<i>NCTC-2080</i>	Cocci					3.3	5.1	8.5	8.3	7.6	7.2	7.6	7.2	7.5	7.7	7.2	7.8	7.8	8.3	8.3	8.3	11.4	
<i>LC-6</i>																							
<i>NCTC-2081</i>	Cocci					3.6	4.8	8.4	8.3	7.4	7.1	7.8	7.3	7.6	7.8	7.5	7.8	7.6	8.3	8.2	8.4	12.1	
<i>LC-7</i>																							
<i>NCTC-2084</i>	Rods					4.8	7.8	9.4	9.3	9.4	9.6	9.1	8.4	8.9	9.3	8.6	9.2	9.3	9.4	9.4	9.4	39.4	
<i>LC-10</i>																							
<i>NCTC-2085</i>	Cocci					3.4	5.0	8.6	8.4	7.6	7.2	7.7	7.2	7.6	7.7	7.6	7.6	7.9	8.5	8.5	8.4	11.9	
<i>SL-2036</i>																							
<i>NCTC-2036</i>	Cocci	1.3	1.8	1.1	0.6	2.4	3.1	5.1	8.3	8.1	7.9	7.5	7.8	7.6	7.7	8.0	6.9	7.5	7.3	8.5	8.5	8.6	14.7
<i>Leishmania</i>																							
<i>NCTC-2037</i>	Rods	2.7	2.8	0.9	0.8	1.3	4.8	8.1	9.7	9.4	9.3	9.6	9.2	7.2	9.0	9.3	9.1	8.8	9.3	9.4	9.4	29.3	
<i>Leishmania</i>																							
<i>NCTC-2038</i>	Rods	0.8	0.8	0.8	0.1	0.1	3.5	4.7	0.8	0.6	0.2	0.7	2.3	1.0	1.3	0.8	0.5	1.0	0.5	0.4	0.3	0.8	13.1

7H₂O and 0.5 gms. of MnSO₄ · 4H₂O dissolved in 250 cc. of water. Five drops of concentrated HCl were added to stabilize the solution.

Procedure

Different media were prepared as given above, pH. adjusted to 6.8 and 10 cc. of the medium transferred into each assay tube. Duplicates and a blank were run in each case. The tubes were sterilized at 10 lbs. for 30 minutes twice at an interval of 24 hours. Three loops of the inoculum were inoculated into each assay tube and incubated at 37° C. for 72 hours. The acid produced during this period was directly titrated against 0.1 N. NaOH to pH. 6.8-7.0 using brom thymol blue as indicator.

The results obtained are given in Table II.

Discussion

From the results presented in Table II, preliminary experiments with undefined media (M. 1-5.) give poor acidity which indicate that they are deficient in growth-promoting factors and are, therefore, not satisfactory. The acidity is improved in M.-6 but is still low when compared to M.-8 and is likely to be due to the absence of a buffer, or the medium lacks the optimum concentration of the growth-promoting substances. Medium-7 compares favourably with M.-8 yet it is lacking in some growth factors present in the latter and which are likely to be of the nature of some essential salts.

The growth and acid production are good in M.-8. The conversion of carbohydrate into acid is between 70-87 per cent. which is quite satisfactory. The acid produced in M.-9 is the same as in M.-8 which clearly indicates that peptonized milk is not necessary when the nitrogen requirements of the organisms are satisfied by peptone, casein hydrolysate, and added amino acids. Besides, lactose can be suitably replaced by glucose. The acid production in M.-10 and M.-12 is the same as in M.-9, which shows that casein hydrolysate with added amino acids can be replaced by peptone and cystine and both together are not necessary. However, the acid production appears to be slightly better in the case of the latter and is possibly due to some growth factors present in peptone.

Lack of cystine in M.-11 and M.-13 has a marked effect on *L.C.-2* and *L.C.-3* whereas the rest of the cultures are very slightly affected. The absence of cystine is more

marked in M.-11 where peptone is the source of nitrogen. This clearly shows that peptone as well as casein hydrolysate lack cystine which needs therefore to be supplemented. The absence of tryptophane in M.-14 slightly lowers the acid production indicating a slight but definite response of the organisms towards this amino acid; casein hydrolysate when used as a source of nitrogen should always be supplemented with tryptophane as it is destroyed during the acid hydrolysis of casein. Absence of added tyrosine in M.-15 does not affect acid production in the case of rods, indicating that the amount present in the casein hydrolysate is sufficient for them whereas cocci are slightly affected which means that their requirements of tyrosine are slightly in excess of those of the rods.

Absence of yeast extract in M.-16 considerably affects *L.C.-2* and *L.C.-3*, to some extent *L.C.-4*, and others, proving that the cultures respond to some factor or factors present in yeast extract besides the synthetic vitamins present in the medium. Insufficiency of vitamins of the B-complex in M.-17 considerably brings down the acid production in the case of *L.C.-2* and *L.C.-3* and to a slight extent in others indicating that cultures *L.C.-2* and *L.C.-3* respond to the synthetic vitamins in addition to the vitamins and factors present in yeast extract and peptone.

The acid production in M.-18 is the same as in M.-10 indicating that the increase in the peptone concentration does not affect the organisms which also proves that the nitrogen level in M.-10 is optimum. In M.-19, an increase in acid production is noted in the case of cocci since the buffering capacity of the medium is increased whereas the rods are unaffected.

Media 20 and 21 are identical with M.-19 but are deficient in yeast extract and synthetic vitamins respectively. The doubling of peptone concentration in media 20 and 21 were intended to replace the growth factors present in yeast extract and the synthetic vitamins respectively. The acid production in M.-20 when compared to M.-16 is improved in the case of *L.C.-2* and *L.C.-3* which clearly shows that the factors present in yeast extract other than the synthetic vitamins present in the medium can partly be replaced by the increased concentration of peptone whereas in the case of the rest of the cultures the acid production is brought back to the original level as in M.-9 which shows

that the factors present in yeast extract can be completely replaced by doubling the concentration of peptone. An identical observation is made in the case of M.-21 when compared to M.-17 which indicates that by doubling the peptone concentration synthetic vitamins can partly be replaced in the case of *L.C.-2* and *L.C.-3* and completely in the case of the rest of the organisms.

A medium (M.-22) completely saturated with the growth-promoting substances, with the carbohydrate concentration increased to 6 per cent. and a corresponding increase in the buffer concentration, was finally tried to secure a maximum titre with each of the organisms. The maximum acid production by rods in M.-22 is 39.4 cc. which is equivalent to about 60 per cent. carbohydrate conversion whereas the maximum acid titre by cocci is only 14.7 cc. which corresponds to only 22 per cent. of carbohydrate conversion. This clearly shows that such a high carbohydrate concentration in the medium is uneconomical even with rods as only about two-thirds of the carbohydrate is converted into acid. Trial experiments with 4 per cent. glucose is observed to be more economical with a conversion of about 80 per cent. of the carbohydrate in the case of rods whereas for cocci 1.5 per cent. glucose in the medium has been found to be quite satisfactory.

The response of N.C.T.C.: 2088 to media tried is not satisfactory.

Summary

1. A study of the nutritional requirements of ten strains of lactic acid organisms in the National Collection of Type Cultures, India, has been carried out with respect to their nitrogen and accessory growth factors.

2. Their cystine and tryptophane requirements have been determined. *l*-cystine has been shown to be an essential amino acid in the nutrition of *L.C.-2*, N.C.T.C.: 2077, and *L.C.-3*, N.C.T.C.: 2078 whereas *l*-tryptophane and *l*-cystine have been found to have a beneficial influence for the rest of the cultures studied.

3. Cultures *L.C.-2*, N.C.T.C.: 2077 and *L.C.-3*, N.C.T.C.: 2078, have been found to respond to vitamins of the B-complex as well as to growth factors present in yeast extract and peptone. In view of their requirements of amino acids, vitamins and other accessory factors they can be employed for the assay of vitamins, amino acids and growth factors.

4. Cultures *L.C. 9*, N.C.T.C.: 2084 and *L. acidophilus* N.C.T.C.: 2087, have been found to be largely independent of an external supply of vitamins and complex growth factors; they can therefore, be economically employed for the industrial production of lactic acid.

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References

- 1 Davis, J. G., and Golding, J., *Biochem. J.*, 1930, **24**, 1503
- 2 Koser, S. A. and Saunders, F., *Bact. Revs.*, 1938, **2**, 99.
- 3 Rahn, O. and Hegarty, C. P., *Proc. Soc. Exptl. Biol. Med.*, 1938, **38**, 218.
- 4 Eagles, B. A., Okulitch, O., & Kadzielawa, A. S., *Can. J. Res. B.*, 1938, **16**, 46.
- 5 Davis, J. G., *J. Dairy Res.*, (1939) **10**, 186.
- 6 Orla-Jensen, S. Otte, N. C. and Snog-Kjaer, A., *Zentr. Bakt., Parasitenk., II, Abt.* 1936, **94**, 434.
- 7 Orla-Jensen *et al.*, *ibid.*, **II, Abt.**, 1936, **94**, 447.
- 8 Orla-Jensen *et al.*, *ibid.*, **II, Abt.**, 1936, **94**, 452.
- 9 Orla-Jensen *et al.*, *ibid.*, **II, Abt.**, 1936, **94**, 460.
- 10 Orla-Jensen Kgl. Danske Vidensk. Selsk. Skriftr., *Naturvidensk. math. Afdel.* 1936, **6**, No. 5, 1.
- 11 Eagles, B. A., Wood, A. J. and Bowen, J. F., *Can. J. Res. B.*, 1936, **14**, 151.
- 12 Snell, E. E., Strong, F. M. and Peterson, W. H., *Biochem. J.*, 1937, **31**, 1789.
- 13 Wood, H. G., Anderson, A. A., and Werkman, C. H., *Proc. Soc. Exptl. Biol. Med.*, 1937, **36**, 217.
- 14 Wood *et al.*, *J. Bact.*, 1937, **34**, 32.
- 15 Kranskopf, E. J., Snell E. E., and McCoy, E., *Erzymbologia*, 1939, **7**, 327.
- 16 Snell, E. E. and Strong, F. M., *Ind. Eng. Chem., Anal. Ed.*, 1939, **11**, 346
- 17 Snell, E. E. and Strong F. M., *Enzymologia*, 1939, **6**, 186.
- 18 Snell, E. E. and Strong F. M., & Peterson, W. H., *J. Amer. Chem. Soc.*, 1938, **60**, 2825.
- 19 Snell, E. E., *J. Biol. Chem.*, 1941, **141**, 121.
- 20 Snell, E. E., *Arch. Biochem.*, 1943, **2**, 389.
- 21 Snell, E. E. and Mitchell, H. K., *Proc. Natl. Acad. Sci., U.S.*, 1941, **27**, 1.
- 22 Snell, E. E., *et al.*, *Arch. Biochem.*, 1942, **1**, 93.
- 23 Snell, E. E. and Strong, F. M., *Proc. Am. Soc. Biol. Chem., J. Biol. Chem.*, 1938, **123**, CXII.
- 24 Campbell, T. E. and Hucker, G. I., *Food Research*, 1944, **9**, 197.
- 25 Snell, E. E., Tatum, E. L. and Peterson, W. H., *J. Bact.*, 1937, **33**, 207.
- 26 Hunter, S. H., *J. Bact.*, 1938, **35**, 429.
- 27 Snell, E. E., Strong F. M., and Peterson, W. H., *J. Bact.*, 1939, **38**, 293.
- 28 Moller, E. F., *Z. physiol. chem.*, 1939, **260**, 246.
- 29 Orla-Jensen, S. and Snog-Kjaer, A., *Rept. Proc., 3rd Intern. Congr. Microbiol.*, 1939, 501.

- 30 Bovarnic, M., *J. Biol. Chem.*, 1943, 148, 151.
- 31 Krehl, W. A., and Strong, F. M., *J. Biol. Chem.*, 1944, 156, 1.
- 32 Snell, E. E. and Wright, L. D., *J. Biol. Chem.*, 1941, 139, 675.
- 33 Moller, E. F., *Z. physiol. chem.*, 1938, 254, 285.
- 34 Moller, E. F., *Angew. chem.*, 1939, 52, 466.
- 35 Moller, E. F., Zima, O., Zung, F., and Wall, T., *Naturwissenschaften*, 1939, 14, 228.
- 36 Bohonos, N., Hutchings, B. L. and Peterson, W. H., *J. Bact.*, 1941, 41, 40.
- 37 Bohonos, N. et al., *J. Bact.*, 1942, 44, 479.
- 38 Carpenter, L. E., Elvehjem, C. A. and Strong, F. M., *Proc. Soc. Exptl. Biol. Med.*, 1943, 54, 123.
- 39 Snell, E. E., Guirard, B. M. and Williams, R. J., *J. Biol. Chem.*, 1942, 143, 519.
- 40 Connor-Johnson, B., *Proc. Soc. Exptl. Biol.*, 1944, 55, 199.
- 41 Snell, E. E., and Peterson, W. H., *J. Bact.*, 1940, 39, 273.
- 42 Stokstad, E. L. R., *J. Biol. Chem.*, 1943, 149, 573.
- 43 Pan, S. C., Peterson, W. H. and Johnson, M. J., *Ind. Eng. Chem., Ind. Edn.*, 1940, 32, 709.
- 44 Lewis, J. C., *J. Biol. Chem.*, 1942, 146, 441.
- 45 Clarke, M. F., Lechycka, M. and Light, A. E., *J. Biol. Chem.*, 1942, 142, 959.
- 46 Wegner, M. I., Kemmerer, A. R. and Fraps, G. S., *J. Biol. Chem.*, 1942, 144, 731.
- 47 Feeney, R. E., and Strong, F. M., *J. Biol. Chem.*, 1942, 142, 961.
- 48 Light, A. E. and Clarke, M. F., *J. Biol. chem.*, 1943, 147, 739.
- 49 Smith, F. R., *J. Bact.*, 1943, 46, 369.
- 50 Pollack, M. A. and Linder, M., *J. Biol. chem.*, 1943, 147, 183.
- 51 Dolby, E. E., Happold, F. C. and Sandford, M., *Nature*, 1944, 153, 619.
- 52 Ju-Hwa Chu, E. and Williams, R. J., *J. Biol. chem.*, 1944, 155, 9.
- 53 Niven, C. F. (Jr.), *J. Bact.*, 1944, 47, 343.
- 54 Gaines, S. and Stahley, G. L., *J. Bact.*, 1943, 46, 441.
- 55 Luckey, T. D., Briggs, G. M., Jr. and Elvehjem, C. A., *J. Biol. chem.*, 1944, 152, 157.
- 56 Rogosa, M., *J. Biol. chem.*, 1944, 154, 307.
- 57 Mitchell, H. K., Snell, E. E. and Williams, R. J., *J. Amer. chem. Soc.*, 1941, 63, 2284.
- 58 Pfiffner, J. J., Binkley, S. B., Bloom, E. S., Brown, R. A., Bird, O. D., Emmett, A. D., Hogan, A. G. and O'Dell, B. L., *Science*, 1943, 97, 404.
- 59 Keresztesy, J. C., Rickes, E. L. and Stokes, J. L., *Science*, 1943, 97, 465.
- 60 Hutchings, B. L., Stokstad, E. L. R., Bohonos, N. and Stobodkin, N. H., *Science*, 1944, 99, 371.
- 61 Day, P. L., Landston, W. C. and Shukers, C. F., *J. Nutr.*, 1935, 9, 637.
- 62 Langston, W. C., Darby, W. G., Shukers, C. F. and Day, P. L., *J. Exp. Med.*, 1938, 68, 923.
- 63 Day, P. L., *Vitamins and Hormones*, New York, 1944, 2, 71.
- 64 Day, P. L., Mims, V., Totter, J. R., Stokstad, E. L. R., Hutchings, B. L., and Sloane, N. H., *J. Biol. chem.*, 1945, 157, 423.
- 65 Moller, E. F., *Angew. chem.*, 1940, 53, 204.
- 66 Orla-Jensen, S., *Annales des Fermentations*, 1937, 3, 1.
- 67 Isbell, H., *J. Biol. chem.*, 1942, 144, 567.
- 68 Pollack, M. A. and Linder, M., *J. Biol. chem.*, 1942, 143, 655.
- 69 Shankman, S., *J. Biol. chem.*, 1943, 150, 305.
- 70 Shankman, S., Dunn, M. S. and Rubin, L. B., *J. Biol. chem.*, 1943, 150, 477.
- 71 Hegsted, D. M., *J. Biol. chem.*, 1944, 152, 193.
- 72 Hutchings, B. L. and Peterson, W. H., *Proc. Soc. Exptl. Biol. Med.*, 1943, 52, 36.
- 73 Kuiken, K. A., Norman, W. H., Lyman, C. L. and Hale, F., *Science*, 1943, 98, 266.
- 74 Kuiken, K. A., Norman, W. H., Lyman, C. L., Hale, F., and Blotter, L., *J. Biol. chem.*, 1943, 151, 615.
- 75 Lyman, C. M., Kuiken, K. A., Blotter, L. and Hale, F., *J. Biol. chem.*, 1945, 157, 395.
- 76 Greene, R. D. and Black, A., *Proc. Soc. Exptl. Biol. Med.*, 1943, 54, 322.
- 77 McMahan, J. R. and Snell, E. E., *J. Biol. chem.*, 1944, 152, 83.
- 78 Stokes, J. L., and Gunness, M., *J. Biol. chem.*, 1944, 154, 715.
- 79 Wooley, J. G. and Sebrell, W. H., *J. Biol. Chem.*, 1945, 157, 141.
- 80 Wood, H. G., Geiger, C. and Werkman, C. H., *Iowa State Coll. J. Sc.*, 1940, 14, 367.
- 81 Snell, E. E., and Guirard, B. M., *Proc. Natl. Acad. Sci., U.S.*, 1943, 29, 2, 66.
- 82 Feeney, R. E. and Strong, F. M., *J. Amer. Chem. Soc.*, 1942, 64, 881.
- 83 Dunn, M. S., Shankman, S., Camien, M. N., Grankl, W. and Rockland, L. B., *J. Biol. Chem.*, 1944, 156, 703.
- 84 Fox, S. W., Fling, M. and Bollenback, G. N., *J. Biol. Chem.*, 1944, 155, 465.
- 85 Snell, E. E., *Proc. Soc. Exptl. Biol. Med.*, 1944, 55, 36.
- 86 Richardson, G. M., *Biochem. J.*, 1936, 30, 2185.
- 87 Snell, E. E. and Mitchell, H. K., *Proc. Natl. Acad. Sci., U.S.*, 1941, 27, 1.
- 88 Stokstad, E. L. R., *J. Biol. Chem.*, 1941, 139, 475.
- 89 Chattaway, F. W., *Nature*, 1944, 153, 250.
- 90 Stokes, J. L., *J. Bact.*, 1944, 48, 201.
- 91 Stern, R. M. and Frazier, W. C., *J. Bact.*, 1941, 42, 479.
- 92 Hegsted, D. M., *J. Biol. Chem.*, 1945, 157, 741.
- 93 Binkley, S. B., Bird, O. D., Broom, E. S., et al., *Science*, 1944, 100, 36.
- 94 Krueger, K., and Peterson, W. H., *J. Biol. Chem.*, 1945, 158, 145.
- 95 Snell, E. E., *J. Biol. Chem.*, 1945, 158, 497.
- 96 Snell, E. E., *J. Biol. Chem.*, 1944, 154, 313.
- 97 Snell, E. E., and Rannefeld, A. N., *J. Biol. Chem.*, 1945, 157, 475.
- 98 Snell, E. E., *J. Biol. Chem.*, 1945, 157, 491.

SOME CHARACTERISTICS OF VANADIUM-BEARING INTERMEDIATE MANGANESE CAST STEELS

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Introduction

THE value of manganese as a strengthening element in carbon steels, especially in those of low carbon content, has now been well recognized. The view that the addition of more manganese to steel than the average renders ordinary mild steel brittle, is probably a survival from early days, when defects in Bessemer steel rails were traced to an unusually high content of manganese. It is universally recognized today that by the use of higher manganese contents than are usually employed, a more desirable structural condition may be obtained in low and medium carbon steels. There is in recent years a distinct tendency to employ for many purposes low and medium carbon steels with considerably higher proportions of manganese than would have formerly been considered desirable.

It is generally conceded that an intermediate manganese steel has attractive characteristics, but erratic results are frequently met with. Our knowledge of the iron-carbon-manganese system is still incomplete. Manganese is known to exist in steel as a double carbide of manganese and iron, and also in solid solution. Under the microscope, intermediate manganese steel occasionally shows distinct segregation, and if the manganese content is in excess, this segregation results in the formation of martensite in the manganese-rich zones, when the steel has been cooled rapidly in air. Fig. 1 shows a typical structure of manganese segregation in a steel containing 0.33 per cent. of carbon and 1.38 per cent. of manganese. The same structure at 1,000 diameters is shown in Fig. 2 where the needle-like pattern of martensite is brought out clearly.

Segregation results during solidification, and its effect can be altered only by correct heat treatment. When segregation takes place, two distinct types of structure are formed. The normal structure is sorbite-pearlite or sorbite, while the areas rich in manganese are really air-hardening or mar-

tensitic in character. Whether or not this non-uniformity occurs depends largely on the ratio between the carbon and manganese contents of the steel. It is, therefore, extremely important to maintain the proper ratio between carbon and manganese in order to obtain uniformity in structure and, therefore, uniformity in physical results.

Another undesirable characteristic of intermediate manganese steel is the tendency for grain growth (Fig. 3). A large grain structure in plain intermediate manganese steel results in low impact values. It is claimed that the addition of 0.10—0.20 per cent. of vanadium to this type of steel produces a conspicuous improvement in micro-structure and physical properties. Grain growth is retarded and the vanadium addition makes possible a different ratio between the carbon and manganese, which results in a steel with relatively superior physical properties and without manganese segregation. The grain refinement alters the critical cooling rate and makes the manganese cast steel less strongly air-hardening. The mechanical properties are shown to be at least equal to the low nickel-chromium steels, in many respects, and in most respects are intermediate between the plain carbon and more fully alloyed steels, though in one respect, notably as regards the notched bar impact test results, some of these intermediate manganese vanadium-bearing steels are actually superior to fully alloyed steel. Furthermore, the intermediate manganese steels are relatively cheap.

In view of the above observations and the view that the use of low and medium carbon intermediate manganese cast steels has not received adequate attention, it was considered desirable to obtain firsthand information on the physical characteristics of these types of steel castings, with and without the addition of vanadium. The investigation was primarily undertaken to appraise independently and to compare our results with those of other workers who attribute attractive qualities to intermediate manganese cast steels.



Fig. 1—Manganese rich zone in rapidly air-cooled intermediate manganese steel. (C=0.33 per cent., Mn=1.38 per cent.) $\times 100$.

Fig. 2—Same as Fig. 1. Note martensite needles of Mn-rich zone at 1000 magnification $\times 1000$.

Fig. 3—Intermediate-Mn steel showing tendency for grain growth $\times 100$.

Manganese is one of the cheapest alloying elements in steel industry. India being the second largest manganese ore producing country in the world (see graph), it is of special interest and importance for this country to study the possibilities of utilizing it in the development of a wide variety of cheap low alloy steels, improved or reinforced by other alloying elements such as vanadium, titanium and zirconium, which are also reported to be abundantly available in this country.*

Pearlitic Manganese Steel for Castings

Manganese when added to cast steel in excess of the amount required either for

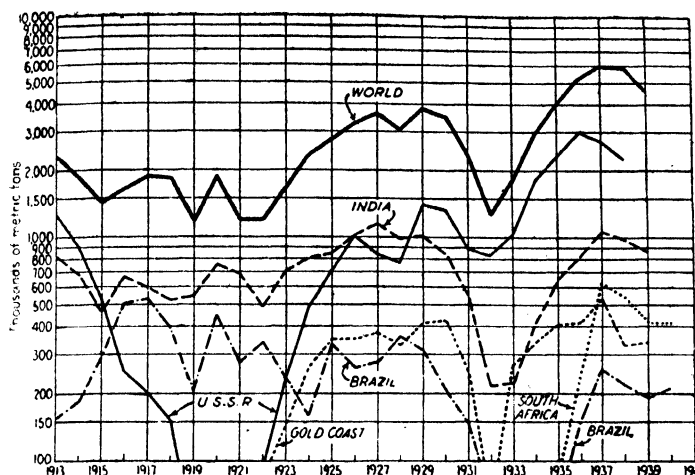
* Regarding India's position, it is found possible to recover the low vanadium content that is found in titaniferous iron ores of Singhbhum and Mayurbhanj. These ores contain from 0.5 to 3.5 per cent. V_2O_5 and the deposits are estimated in the neighbourhood of five to six million tons. As 50 to 70 per cent. of vanadium is recoverable from the ore, it is obvious that by extracting this metal by a process ensuring economy, India would be able to meet not only her own requirements, but the world's demand as well. Experiments carried out in the Research and Control Laboratories of the Tata Iron and Steel Co., Ltd., Jamshedpur, have shown that the efficiency (recovery) from roasting to ignition (sintered V_2O_5) is of the order of 70 per cent. Based on the results of these experiments, the Steel Company is erecting a plant with a capacity to treat about seven tons of titaniferous vanadium-bearing ore per day. Taking an average of 2.5 per cent. of V_2O_5 in the ore, a ton of ore would yield about 39 lbs. of sintered V_2O_5 . Typical analytical results of titaniferous iron ore from Mayurbhanj, and sintered V_2O_5 prepared from this ore, are given below:

Mayurbhanj Titaniferous Ore.

	%		%
Fe_2O_3	= 70.78	MgO	= 0.30
TiO_2	= 15.32	CaO	= 0.15
FeO	= 6.45	Cr_2O_3	= 0.04
Al_2O_3	= 2.38	P	= 0.009
V_2O_5	= 2.20	H_2O (Ign.)	= 0.86
SiO_2	= 1.20	NiO_2	= Nil
MnO	= 0.37		
		Total	= 100.059

Sintered V_2O_5 .

V_2O_5	= 92.00
Fe_2O_3	= 4.43
TiO_2	= 0.90
Al_2O_3	= 0.56
SiO_2	= 0.80
NaCl	= 1.56
Total	100.25



Graphical representation of Manganese ore output in India, the U.S.S.R. and other major countries.

deoxidation or for the conversion of the sulphur to manganese sulphide, must be considered a true alloying element. Manganese has a favourable influence upon the mechanical properties of cast steels, promoting high strength accompanied by satisfactory ductility. Cast steel of 1.00 to 2.00 per cent. manganese and 0.25 to 0.40 per cent. carbon has received the attention of designing engineers because of the excellent properties that can be developed by a normalizing heat treatment. Among the intermediate manganese steels there are three main types :

- 0.25 to 0.35 per cent. carbon, 1.05 to 1.35 per cent. manganese.
- 0.30 to 0.40 per cent. carbon, 1.35 to 1.55 per cent. manganese.
- 0.30 to 0.40 per cent. carbon, 1.70 to 2.00 per cent. manganese.

These steels are seldom used in the full annealed condition because the property values obtained do not justify the cost of the alloying element. They show their best properties on normalizing. The normalizing treatment may or may not be followed by tempering. The effect of a high tempering treatment is to increase the ductility and impact value with a decrease in yield point and tensile strength. The mechanical properties both with and without tempering treatment are satisfactory and the choice of the treatment is dependent upon the use to which the casting is to be put. Typical physical values normally expected in the

manufacture of the above types of intermediate manganese cast steel have been published in *Steel Castings Handbook*, (Steel Founders' Society of America, 1941).

As stated before, only a homeopathic addition of approximately 0.10 per cent. of vanadium to intermediate manganese cast steel produces a conspicuous improvement in both the microstructure and the mechanical properties. The usual composition of Mn-V cast steels falls within the following range :—Carbon, 0.25 to 0.35 per cent. ; Manganese, 1.4 to 1.70 per cent. ; Silicon, 0.25 to 0.50 per cent. ; and Vanadium

0.08 to 0.12 per cent. Some of the known mechanical properties of Mn-V cast steels differently heat treated have been given in the above-mentioned *Handbook* and in a booklet entitled *Vanadium Steels and Irons* published by the *Vanadium Corporation of America*.

Steels Investigated

A series of heats* was made in a 75-lb. high frequency induction furnace and cast into dry sand moulds to give the sample test blocks of the dimensions shown in Fig. 4. The same figure also illustrates the position of test pieces for impact and tensile strength determinations. Fig. 5 shows a photograph of one of the test blocks. In all, nine heats were selected for the investigation. No aluminium as such was used in any of these heats. Since a wide variation in either the carbon or the manganese contents of the heats would render the comparison incorrect, it was decided to select only those heats which analytically compared favourably with each other. The comparison heats consisted of low and medium carbon intermediate manganese (1.35 to 1.65 per cent. Mn.) steels with vanadium varying from nil to 0.22 per cent. A cast block containing 0.43 per cent. of carbon and 0.79 per cent. of manganese was also included for comparison, as a large bulk of small and big commercial castings are often made of approximately this composition. Chemical

* See Appendix.

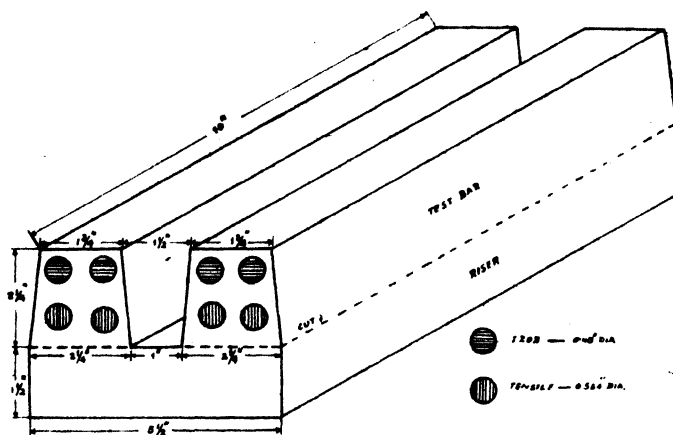


Fig. 4.—Outline drawing showing positions of test-pieces in test block.

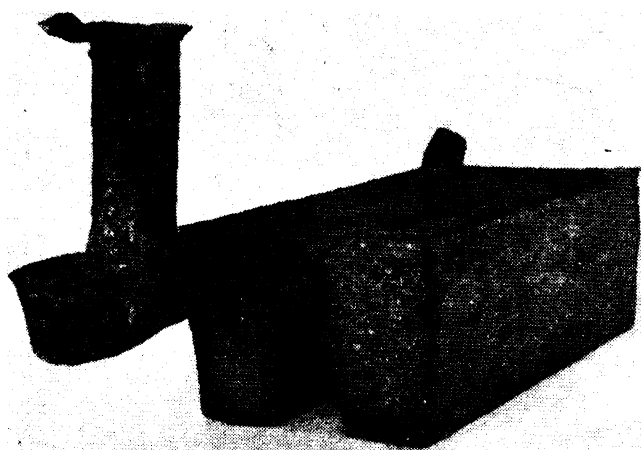


Fig. 5—Test-block casting.

analysis of the cast steels investigated are given in Table I.

TABLE I. *Analysis of Cast Steel*

Cast Steel No.	[Analysis %]					
	C	Mn	Si	S	P	V
1	0.25	1.47	0.36	0.027	0.026	Nil
2	0.24	1.45	0.35	0.024	0.026	0.09
3	0.22	1.42	0.31	0.022	0.027	0.12
4	0.23	1.42	0.38	0.024	0.026	0.22
5	0.31	1.57	0.32	0.024	0.028	Nil
6	0.30	1.59	0.38	0.021	0.022	0.08
7	0.29	1.60	0.35	0.026	0.023	0.14
8	0.30	1.56	0.29	0.020	0.022	0.22
D	0.43	0.79	0.29	0.017	0.021	Nil

It may be pointed out here that the test pieces investigated may not represent the physical properties of all parts of commercial castings. The structure, and consequently the properties, produced depend upon the rate of cooling from the casting temperature and the rate of cooling from normalizing. Obviously both are dependent upon the size and shape of the section. Consequently if there is considerable difference between the size of the casting and the size of the test block, there may be differences also in physical properties. However, the same comparisons which are made between the different types of steel and the effects of different treatments as applied to the test blocks would probably hold true for the castings, although the *actual* figures might be different. Furthermore, one of the important factors which governs the properties of castings is the cleanliness and soundness of the steel. As vanadium is cleaner, there is a greater probability of producing sound castings when vanadium is employed as an ingredient.

The results of physical tests on cast steels are given in Table II. An examination of the results indicates that vanadium has a greater influence on the yield strength of cast steels than on tensility, which is more or less unaffected. There is a slight but distinct improvement in ductility with the alloying of vanadium. Impact strength, like yield strength, is decidedly improved upon by the addition of vanadium. It is not possible, within the scope of the present work, to define the influence of various heat treatments on plain intermediate manganese cast steels and those containing vanadium.

The influence of vanadium does not appear to be a straight line function. In other words, the beneficial effect of vanadium

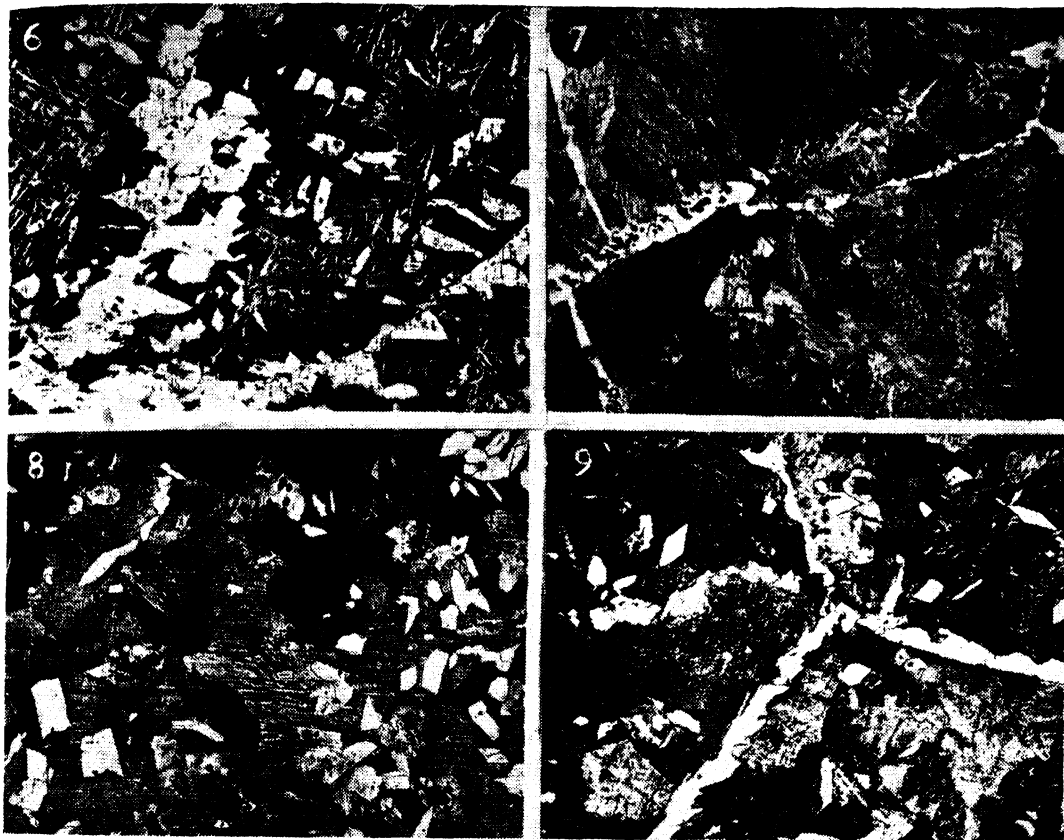


Fig. 6—As cast structure of steel 1. Note the Widmanstätten pattern $\times 100$.

Fig. 7—As cast structure of steel 5. Note coarse grains with dendritic formation $\times 100$.

Fig. 8—As cast structure of V-bearing steel 6. Note the absence of coarse grains and Widmanstätten pattern. Compare with Fig. 6 $\times 100$.

Fig. 9—As cast structure of steel D $\times 100$.

is felt when it is present in small doses of 0.08 to 0.12 per cent. beyond which no further improvement appears to take place. Comparison of steels 1 to 8 (Table II) with steel D, clearly indicates the superior physical characteristics of the intermediate manganese cast steels over those of plain carbon type containing 0.65 to 0.85 per cent. manganese.

Figs. 6 to 9 illustrate the as cast microstructure of steels 1, 5, 6 and D. Typical Widmanstätten pattern is associated with the as cast structure of steel 1 (Fig. 6), which does not contain vanadium. The grains are large and surrounded by a network of ferrite which is present as plates

in crystallographic planes inside the pearlite. Fig. 7 is a photomicrograph of vanadium-free steel 5 in as cast condition. Here again the grains are coarse, with a relatively thin network of ferrite due to high percentage of carbon and manganese as compared with steel 1. Fig. 8 illustrates the as cast microstructure of steel 6, which is chemically almost identical to steel 5 (see Table I) but in addition contains 0.08 per cent. vanadium. It is characterized by the absence of Widmanstätten patterns of steel 1 (Fig. 6) or coarse grained dendritic formation of steel 5 (Fig. 7). The grains are relatively small and uniform in size, thus assuring better physicals after a given heat treatment. Fig. 9 is illustrative of the as cast micro-

show the normalized structure of steels 5, 6 and D, respectively. They further show that the microstructural advantage of vanadium cast steels noted above, namely, less marked dendritic form or absence of Widmanstätten patterns and the formation of fine and uniform grains, persists after the heat treatment.

In conclusion, it may once again be emphasized that in view of India's unique position with regard to manganese ore deposits, it is of great national interest to undertake a comprehensive study of the development and production of relatively cheap steels containing varying amounts of manganese as an alloying element, reinforced by other elements, such as vanadium, titanium and zirconium, the raw materials for which are also reported to be available in this country.

Acknowledgment

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APPENDIX

Manufacturing Features

Although no difficulty was encountered in the manufacture of the reported experimental heats, it is felt that the finishing of a commercial manganese heat in the furnace and the use of silico-manganese for making low carbon heats involve special problems in furnace operation, which although solved to a considerable extent during recent years, still deserve further study. The special feature involved is the necessity of adding rather large quantities of manganese and at the same time, keeping the carbon content relatively low. As manganese is eliminated from the bath of steel by oxidation more easily and

rapidly than carbon, the alloy additions used to obtain the desired manganese content must not raise the carbon above that required in the finished steel. This can be accomplished by using silico manganese (containing from 0.60 to 1.25 per cent. of carbon) or special low-carbon ferro-manganese alloys. In order to keep the silicon content low in the finished steel, silico manganese should be preferably added to the furnace to a mild or only partly deoxidized bath, so that most of the silicon will be oxidized out. Manganese additions should, if possible, always be made in the furnace. It is too true to say that heats finished in the ladle could not be as clean nor as uniform as those made entirely in the furnace.

The practice in making these steels in the electric furnace is much the same as that in the open-hearth, except that in the former the heat may be finished with a neutral or slightly reducing slag and the loss of manganese to the slag may be largely eliminated. After a heat is melted under an oxidizing slag and the carbon reduced to a value slightly below the final figure desired, silico manganese may be added to give a manganese content somewhat below that of the final analysis. The slag is then carefully deoxidized by sprinkling carbon over its surface. It is also desirable to add powdered ferro-silicon and aluminium at this stage in order to control the bath so that maximum efficiency with regard to the recovery of manganese (and vanadium) may be attained. When the slag is neutralized, a sample for analysis is taken from the bath and the final additions of silico-manganese or ferro-manganese (and ferro-vanadium) are made and the heat held for some time, say 10 to 15 minutes, before tapping. Small additions of ferro silicon or aluminium may, of course, be made for final deoxidation. Consistent recoveries of manganese may not be obtained in the early stage of manufacture because of a variable loss of manganese. If the additions of manganese alloy are not quickly absorbed by the steel, or if they are melted under the arc, a large loss seems possible. It is always preferable in making furnace additions to have the alloy in fairly large masses so that it will sink through the slag and be quickly absorbed by the bath. Regarding the vanadium recovery, it is estimated that if the bath is well controlled and correctly deoxidized, it would be between 50 and 70 per cent., although higher recoveries have been known. In vanadium-bearing steels reported here, the recovery of vanadium was usually of the order of 80 per cent., the ferro-vanadium used containing 54.6 per cent. V, 1.57 per cent. Si, 0.22 per cent. Mn and 0.09 per cent. C.

PRODUCTION OF SODIUM TAUROGLYCOCHOLATE

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SODIUM tauroglycocholate, synonymous with bile salts, consists chiefly of a mixture of sodium taurocholate $C_{26}H_{42}O_7NSNa$ and sodium glycocholate $C_{26}H_{42}O_6NNa$. A large amount of work has been carried out on the isolation and constitution of individual bile acids by Wieland, Windaus and Ruzicka. There appears to be little or no published information on the details of preparation of sodium tauroglycocholate and the economics of the process.

Experiments on the production of sodium tauroglycocholate from fresh ox bile, as well as from mixed bile obtained from cow, ox and he- and she-buffalo, have been carried out. The mixed bile being available in comparatively larger quantities it was employed as the starting material.

The bile is first dried over a porous material and subsequently extracted with alcohol. The porous material used is some form of activated carbon, animal or vegetable, the choice being determined by the cost. Besides offering a large surface for drying, the activated carbon adsorbs the colouring matter and gives a comparatively colour-free preparation.

Experimental

450 gms. of norit were extracted with 1,500 cc. of water for 0.5 hour and filtered hot at the pump, washed with hot water (500 cc.) and dried in a steam oven (yield 445 gms.). The washed product was employed in the preparation of sodium tauroglycocholate.

3,125 cc. of fresh mixed bile (sp. gr. 1.018 at 31° C.) obtained from the slaughter-house were mixed with 250 gms. of washed norit and evaporated to dryness on the water bath. The drying was continued (8 hours) till the whole mass could be easily powdered. The dried mass was powdered and transferred to a 3-litre round-bottomed flask and refluxed with 1,563 cc. of alcohol (95 per cent.) for 3 hours. The extract was filtered on a Buchner funnel under mild suction and the residue washed with 150 cc. of alcohol. The alcoholic extract was concentrated and most of the

alcohol (1,162 cc.) recovered. The concentrate was evaporated to dryness in a porcelain dish first over a water bath (4 hrs.) and then in a steam oven for one hour. The dry extract (130 gm.) was coarsely powdered, refluxed with 290 cc. of alcohol (97 per cent.) and filtered. To the filtrate, ether (260 cc.) was added till there was no further precipitate or opalescence. The sodium tauroglycocholate which separated as a viscous oily liquid, on seeding with a few crystals of the pure salt from a previous charge, and on standing for 4 hours, crystallized in beautiful long radiating needles. The mass was stirred from time to time, to prevent caking up. The crystals were filtered on a Buchner funnel under suction, and dried over calcium chloride and then in a steam oven, and bottled. Yield 84.5 gm. (sulphated ash, 14.02 per cent. ; Na, 4.54 per cent.). The filtrate (205 cc.) after treatment with a further volume of ether (200 cc.) gave a second crop of crystals (yield 10.7 gms.) on keeping.

The carbon residue was extracted for a second time with alcohol (782 cc.). After refluxing for 3 hours, the hot mixture was filtered as before and the residue washed with alcohol (150 cc.). The filtrate and washings (890 cc.) were concentrated and evaporated to dryness (yield 55.5 gms.).

The dried extract was dissolved in hot alcohol (20 cc.) and after filtering from the insoluble inorganic salts, the sodium tauroglycocholate was precipitated by addition of ether as described above. The first and second crops weighed 35.0 gms. (sulphated ash, 14.20 per cent. ; Na, 4.60 per cent.) and 2.4 gms. respectively.

The total yield was 132.9 gms. The total weight of the first crop of crystals was 119.5 gms. or 3.76 per cent. on the weight of the bile.

The mixed bile varies in sp. gravity from 1.014 to 1.018. In all experiments, fresh bile of not more than 10 hours' standing was employed.

Both norit and locally prepared activated carbon, e.g., bagdicol, were used with satisfactory results. Attempts were made to economize the use of carbon not only by

TABLE I

Expt. No.	Vol. mixed bile c.c.	Sp. gr.	Activated carbon used %	Total solids in bile %
4	2,090	1.014 at 29°C.	8 Norit.†	5.55
5A	1,750	1.016 at 32°C.	8 Bagdicol.	6.31
5B	590	1.016 at 32°C.	8 Norit once used.	7.35
6	3,600	1.020 at 29°C.	8 Norit.	6.93
7	3,125	1.018 at 30°C.	8 Norit.	7.39
8	3,750	1.018 at 30°C.	8 Norit once used.	6.96
9	3,060	1.018 at 31°C.	6 Norit.	6.89
10	3,800	1.018 at 30°C.	5 Norit.	6.97
11	1,900†	1.018 at 28°C.	4 Norit once used.	6.84
12	3,050	1.018 at 30°C.	4 Norit twice used.	7.10

TABLE II

Expt. No.	Alcohol for extraction and washing c.c.	Wt. of dried alcoholic extr. gms.	Alcohol for dissolving dried extract. c.c.	Ether added for 1st and 2nd crystallization. c.c.	Yield of bile salt in gms.	
<i>First Extraction</i>						
					1st crop	2nd crop
4	900	67.0	170	270	50.0	1.0
5A	980	69.9	140	220	45.7	6.0
5B	270	31.5	63	80	18.0(14.57)*	0.5
6	1,650	119.0	210	360	79.5(14.02)	3.0
7	1,713	130.0	290	960	84.5(14.02)	10.7
8	1,650	188.0	376	540	120.0	10.0
9	1,730	179.0	500	930	86.0	15.5(15.8)
10	1,670	203.0	510	900	170.0	8.0(16.7)
11	810	112.0	270	580	103.0	3.7
	1,625	188.0	386	901	172.0(17.86)	0.4
<i>Second Extraction</i>						
5A	600	56.0	100	100	14.5	
	500	25.6	51	60	19.0	
5B	123	4.8	15	15	3.8	
6	700	34.7(15.5)†	100	204	18.5	
7	932	50.5	120	140	37.7(14.20)	
8	850	37.9(19)†	110	160	29.1	
9	1,016	25.0(10.5)†	29	170	27.1	
10	1,012	35.0(14.0)†	95	145	38.3	
11	506	18.0(8.5)†	53	113	24.0(29.73)	
12	862	21.5	43	84	17.1	

* Figures in brackets represent percentage of sulphated ash.

† These refer to dried alcoholic extract from the third extraction.

using smaller proportions on the bile used, but also by reusing the activated carbon. The proportion of carbon used for drying has a profound influence on the yield of sodium tauroglycocholate. In the preliminary experiments, when 50 per cent. and 20 per cent. carbon on the weight of bile was used, the yield was 1.5 and 2.5 per cent. respectively. The details of drying the mixture of bile and activated carbon are given in Table I. The solid contents of the biles of sp. gravity 1.018 and 1.014 were respectively 7.02 and 5.55 per cent.

The details of the extraction of the dried (with activated carbon) bile solids with alcohol, and the preparation of sodium tauroglycocholate are given in Table II. In the case of experiments 6, 8, 9, 10 and 11 the residue from the second and third extraction were used for the preparation of bile salt. The quantity of alcohol for dissolving the dried extract, ether added for precipitation and the yield of bile salt obtained, refer to the combined residues from second and third extractions.

Discussion of Results

In experiments 4, 5A, 6, 7 and 8, in which the dried alcoholic extract was dissolved in hot alcohol and the resulting solution filtered in order to remove the insoluble inorganic salts, the product obtained has a lower sodium and sulphated ash content than that obtained when the filtration was omitted. The inorganic salt was found to be mainly sodium chloride. For getting a product satisfying the *B.P. Codex*, 1934 specification, it was found necessary to omit the removal of inorganic salt by filtration.

The use of smaller proportions of activated carbon, besides being economical, leads to a smaller percentage loss of alcohol and a much higher practical yield of bile salt. The use of 4 per cent. norit on the bile is the minimum practicable.

Activated carbon can be used more than once, at least three times and probably more often.

The recovery of bile salt on the dried alcoholic extract is high (84 to 92 per cent.) if the volume of ether used for the precipitation is 1.63-1.75 times the volume of alcohol employed for dissolving the dried alcoholic extract, the volume of alcohol for dissolving 100 gms. of dried alcoholic extract being 240 c.c.

The bile employed must be fresh or well preserved. In the case of putrid material (experiment 9), it was difficult to dry the alcoholic extract. The material was sticky and a large quantity of alcohol was necessary for extraction. The practical yield of sodium tauroglycocholate on the weight of the dried alcoholic extract was also low.

Using 4 per cent. (w/v) norit which has been previously used, the yield of bile salt per litre of the bile was higher when the dried residue from the bile with norit was exhausted three times, than when it is extracted only twice. The per cent. yield on the basis of the dried alcoholic extract was not affected by the frequency of extraction. In actual practice, as the activated carbon can be employed over and over again, the residue left after two extractions can be dried with a fresh quantity of bile, thus obviating any loss due to incomplete extraction.

For the extraction of the dried bile solids rectified spirit is satisfactory; for redissolving the dried alcoholic extracts, however, alcohol of a higher strength is preferable.

Procedure

Fresh bile (100 litres) is mixed with 4.5 per cent. (w/v) norit (or any activated vegetable carbon which has been previously extracted with hot water and dried in stainless steel vessels at 100° C.). The mixture is evaporated to dryness at a temperature not exceeding 100° C. The dry mixture is heated under reflux with 50 litres of rectified spirit for three hours and then filtered warm under slight suction. The residual cake is washed with 3.3 litres of rectified spirit and is extracted a second time using 25 litres of alcohol. The extracts from both the operations are mixed and the mixture heated over a water bath to dryness. The solvent is recovered in the process. The residue is dissolved in hot alcohol using 1.76 litres of alcohol per kilo of dried extract, and the resulting solution treated with 3.5 litres of ethyl ether. The mixture is then seeded with sufficient sodium tauroglycocholate crystals and allowed to stand in a cool place, preferably in a refrigerator, for about 6 hours. The crystals that are separated out are filtered, dried first in the air and finally in the hot air chamber at 80-90° C. Approximate yield 12 to 14 lbs. satisfying the 1934 *B.P. Codex* specification.

The costs of production are given below:—

	Rs. as.
300 liters of mixed bile (672.5 lbs.) at Rs. 8 per lb.	336 4
26.9 lbs. of activated carbon at Rs. 2 per lb.	53 0
18.69 gallons of alcohol lost	93 8
72 lbs. of ether at Rs. 2-8 per lb.	180 0
	<hr/>
	Rs. 662 12
Operation, overhead charges, depreciation, etc., at 20 per cent. on the cost of raw materials	132 4
	<hr/>
	Rs. 785 0

Yield of sodium tauroglycocholate=40 lbs.
∴ cost of sodium tauroglycocholate per lb.=Rs. 20.

The cost is expected to be less considering that activated carbon can be reused more than once.

The author wishes to express his sincere thanks to the late Rai Sahib K. C. Mukerji, M.Sc., A.R.I.C., for his keen interest in this work.



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FOOD SUFFICIENCY

THE final report of the Famine Inquiry Commission is a document of exceptional interest demanding close study. It gives a clear analysis of the Indian food situation and attempts to lay down a policy for food production and administration. The Commission's first report which appeared in May last dealt mainly with "the causes of the food shortage and subsequent epidemics in India, and in particular in Bengal, in the year 1943." The present report deals along with other matters with the "possibility of improving the diet of the people and the quantity and yield of food crops." The problems ancillary to such an inquiry include technical and administrative measures, population trends, land tenures and a large number of economic and social questions. The report surveys the problem as a whole and has defined the broad lines of a food policy designed to prevent any further threat of famine and to improve the diet of the population.

The problem of food is of fundamental and compelling interest to India, and since the time of the tragic Bengal famine (1943), the problem has attracted widespread attention. The famine brought out, in a most distressing manner, the gravity of the food situation in India. The bulk of the population lives on the brink of starvation and the progressive increase in the population without any perceptible expansion in agricultural production, has resulted in a *per capita* decline in food consumption, resulting inevitably in serious malnutrition and deterioration in health and physique. The situation is grave, and unless ameliorative steps are taken, and taken immediately,

the consequences may prove disastrous. The only way out of the depressing situation is to increase food production. This is possible, and if the resources are properly mobilized and utilized, agricultural production can be raised to meet the requirements adequately, after making due allowance for the normal growth of population.

The Government of India initiated, in 1942, the "Grow-More-Food Campaign." The steps taken, viz., bringing new land under food and fodder crops, increasing irrigation facilities, extending the use of manures and increasing the supply of improved seeds, cover the more important practical measures for increasing food supply. If the results obtained are not spectacular, it is because the main requirements for a large increase in agricultural production were absent. The area of cultivable but uncultivated land which can be brought under production without the application of special and expensive measures is small. Provision of improved water-supply through irrigation schemes takes time. A large increase in the supply and use of manures, which will lead to substantial increase in yields, demands intensive and sustained effort. This is true also of the extensive use of improved seeds. The desired results can be achieved by laying down a sound agricultural policy, based on attainable possibilities in terms of a time schedule.

The report rightly points out that "The State should recognize its ultimate responsibility to provide enough food for all. We enunciate this here as a broad principle, the implications of which emerge from the report as a whole. In India the problems of food

supply and nutrition are fundamental and must at all times be one of the primary concerns of Central, Provincial and State Governments. It is abundantly clear that a policy of *laissez faire* in the matter of food supply and distribution can lead nowhere and would probably end in catastrophe. All the resources of Government should be brought to bear in order to achieve the end in view." The emphasis on State responsibility for feeding the people and the suggestion that all the resources of the Government should be utilized for food production will find wide support. The report also discusses the important question whether agricultural production in the country is generally organized so as to be capable of realizing the technical possibilities of increased production. In the ultimate analysis, it is the agriculturist with his small holding that produces food. He must be the background of all planning. It is essential that his methods must be improved, his prejudices conquered, his implements and cattle improved, and his financial resources expanded. Technological researches have indicated the possibilities of developing food production, but for such possibilities to become operative, a correct appraisal of the farmer's position is necessary.

Food sufficiency can be ensured only by harnessing science to farm practice. Science and not tradition should determine the agricultural policy. Modern science has provided several techniques of great value to productive activity. To carry the fruits of scientific research to the ryot is a formidable undertaking, but it must be attempted and it can be achieved. The methods of operational research and statistics are of immense value in this undertaking. One of the biggest developments in war-time science is Operational Research. It originally grew up from a study of the technical problems arising in the use of new equipments and devices introduced into the Services. Towards the end of the war, British scientists had built up a well organized science in which technical scientific work ran parallel with operational scientific work. That the methods of operational research can be applied directly to agricultural problems has been indicated in an article which appeared in an earlier issue of this *Journal*.* Operational Research is concerned with the scientific analysis of the whole field

of productive activity and is concerned with what one wants to do, what means one has for doing it and the quantitative assessment of the results of using these means in actual production.

Agricultural production, like any other productive activity, is a complex of several interacting problems. The effective solution of these problems cannot be left to blind chance or to traditional methods of trial and error. The resources of statistics should be called in to furnish answers from a study of small samples. Statistical methods furnish the most powerful tools in estimating needs, which is the primary step in satisfying them. Large-scale application of statistics is essential for the effective planning of agricultural production.

The qualitative aspect of the food problem is no less important than the quantitative aspect. Nutrition surveys have revealed that while 30 per cent. of the population does not get enough to eat, the diet of a large proportion is deficient in important food factors. It has been shown that, despite ignorance and prejudice, the average Indian improves the quality of his food if he gets a little more money to buy it. The whole question of quality of food is inextricably bound up with the standard of living. The measures adopted for raising economic standards will result also in the improvement of dietetic standards and, therefore, of the general level of health and efficiency.

The growth of industry will help to solve many problems of food and rural economy such as excessive population pressure on land and rural employment. The development of the natural resources to produce more food and to raise the economic level through industry calls for a new spirit and a new determination. In the concluding part of the report it is observed, "India does not lack the material resources necessary for advancement and prosperity but these can be developed only by the efforts of human beings—by the Governments and people of India—and success depends on the spirit which sustains the country in the tremendous task with which it is faced." Faith in the proved possibilities of science and determination to apply the results of scientific research for the development of the agricultural resources are essential not only to avoid the spectres of starvation and malnutrition, but also to ensure a satisfactory standard of health and vigour for India's population.

*1944, 2, 81.

INDUSTRIAL AND ECONOMIC ACTIVITY

—POLICY AND PROGRESS

IN his opening speech at the meeting of the Policy Committee on Industries held in New Delhi on 5th October 1945, the Hon'ble Sir Ardeshir Dalal announced that Government had under consideration the establishment of:—

1. A Government shipbuilding yard for the building of merchant ships and vessels for the Indian Navy;
2. An industry for building aircraft for civil aviation and for the Royal Indian Air Force;
3. An Industrial Finance Corporation for financing medium and large-scale industries;
4. Provincial institutions similar to (3) to finance small-scale and cottage industries; and
5. A Tariff Board to examine, in particular, the claims for assistance or protection to war-time industries.

Referring to the question of the constitutional protection that British capital enjoys under the *Government of India Act*, the Planning Member said, "the immediate consideration of this question has been rendered difficult because of the constitutional discussions which are shortly to come off. It has been suggested that this question may be considered as a part, as indeed it is, of the general constitutional settlement between India and England which is on the anvil. Should, however, a final constitutional settlement between the two countries take a number of years, as well it might, it is not possible for the industrial development of India to proceed unhindered so long as these constitutional provisions remain on the Statute Book."

The first economic consequence of the cessation of the war, Sir Ardeshir Dalal said, in his address to the meeting of the General Policy Committee (8th October 1945), was fall of employment of the order of 2 million and the secondary employment that might be associated with it. "Our problem is to find employment for as many of these men as possible."

There are factors in the economic situation which suggest that there would be spontaneous activity in the country to counteract the

effects of unemployment. There was at the moment a great deal of reserve purchasing power in the country. There was a considerable arrear demand for various types of goods and services. The most important arrear lay in the building industry. Research on pre-fabrication, standardization of shapes, mass-production of fittings, designs, etc., was being undertaken by the *Council of Scientific and Industrial Research*.

Apart from the various development plans including large irrigation and hydro-electric works, the Central and Provincial Governments had to recondition plants, buildings, roads, etc., neglected during the war. Projects were being urgently prepared for starting public works which were capable of being put into operation at short notice and in which the ratio of expenditure to employment was high.

The main factor in maintaining economic activity, however, would be private investment. Measures were being taken to assist private industry. The revival of international trade might be expected. It would be the endeavour of Government to secure a fair share of the trade of Japan.

Special priority schemes undertaken by the Central Government related mainly to the training of personnel in various technical subjects. Training facilities within the country were being expanded, and an All-India medical centre and a technological institute were proposed to be set up. The expansion of the Geological Survey had been undertaken.

Plans, the Hon'ble Member said, had to be prepared on a severely practical basis, taking into account not merely limitations inherent in the country's economy, such as man-power, technical ability and finance, but also limitations imposed by outside forces, e.g., the difficulty of securing capital equipment for industry.

Sir Ardeshir concluded: "Once the political difficulties which confront us so acutely and hinder our progress in so many directions are over, you will find that foundations have been laid and ground-work prepared on which to erect a sound edifice of a future free and prosperous India."

SECONDARY METALS

COLLECTION, SEGREGATION AND METALLURGY

By DARA P. ANTIA

"SECONDARY metal" may be defined as metal recovered from commercial scrap, that is, scrap that has entered the processor's plant in scrap form. Metal recovered by a manufacturer from scrap arising out of his manufacturing processes in his own plant, which he can readily re-convert into finished product, should not be considered as secondary metal. In contrast to virgin or primary metals, i.e., metals extracted from ores, secondary metals are of secondary origin and result from the use of primary metals and alloys.

Secondary metals are most frequently referred to as scrap metals and according to their source can be divided into two important groups : first, the industrial scrap, resulting from the manufacture of wrought and cast metals and alloys, and second, scrap arising from fabricated metal products which have outlived their usefulness. The secondary metal industry also performs two distinct functions ; first, reworking of the secondary metal in order to bring it to its virgin or pure state, so that it can perform all the functions to which primary metal derived from ores is put ; and second, manufacturing standard alloys for which primary metals are generally used. In general, then, the secondary metal industry comprises of remelters, smelters, refiners and manufacturers that convert scrap metals and residues to produce refined metals, ingot alloys, fabricated shapes and chemical products.

Problems of Collecting and Grading

Even in countries where well planned large-scale manufacturing processes are carried on, the collection and grading of scrap present many problems and difficulties. Metals and alloys which visually look alike, or are even identified by the same general name, may contain large or small amounts of other elements and it is absolutely necessary to keep the different kinds of scrap separated to make it easy for the scrap processors to know what they are buying or how they are going to process it. In India, where large-scale manufacturing is conspicuous by its absence, it is all the more necessary that the different plants give some extra

thought to collection and segregation of scrap arising in their plants. However, all the care taken to segregate scrap metals will be wasted if the so-called "junk" merchants who buy scrap from different sources, mix it up before selling it to processors. For this reason, it is absolutely essential for the secondary metal industry to form an association of scrap dealers who can be initiated into the art and science of segregating and grading scrap. Technical advice can be given to this association by customers who buy the scrap for processing and the Chamber of Commerce or the Provincial Director of Industries must advise the scrap producers to sell their scrap only to members of such a recognized association.

The first problem then is that of the producer of scrap. On how well he can reclaim and segregate his scrap depends the whole future of the secondary metal industry. Indian management has been lacking a great deal in the general cleanliness of their plants. Cleanliness is the first condition in the proper segregation of scrap. The dust and contamination from oil, etc., needs extra processing of the scrap and to that extent lowers the price it can fetch in the market. Each industry, each factory and each locality faces a different set of conditions. However, irrespective of the size of the plant, certain fundamental principles can be applied for organization and collection of scrap.

In the interest of clean scrap, there should be appointed a foreman who along with his other duties understands the handling of scrap and should be given enough responsibility to devise his own ways and means of collecting scrap. Enough floor space should be provided in the factory for storing, and proper accounting of all the scrap should be aimed at. Also, the scrap should be segregated daily and a quick market should be found for the scrap so as to avoid storing large quantities. The management should take an active interest in seeing that the scrap is kept segregated.

Though metallurgical processes are available for separating alloys into their

constituent metals, there are economic limitations to the use of such processes. For instance, it will be more economical to melt a selected quality of brass, refine the molten metal to some standard specification and cast it into ingots for further fabrication rather than melt any collection of brass to try to recover copper, zinc, etc., separately. This economy can only be realized if the scrap metal is separated into classes which resemble the original alloy composition as nearly as possible. For example, lead is difficult to remove from leaded brass; hence leaded alloys should be kept separate from zinc or tin alloys. Similarly, antimony is difficult to separate from copper-base alloys and aluminium; silicon and manganese cannot be separated from copper-base alloys containing high percentages of zinc without losing a large amount of zinc. Hence it is necessary to segregate these different kinds of alloys in order to facilitate recovery of the metals and also to fetch a higher price for the scrap. Segregation should, as far as possible, be done right at the source of the scrap producing unit. Separate containers with large markings should be provided in the machine shops, etc., and the workers should be instructed to put their scrap only in particular containers.

Rapid Scrap Identification Tests

In spite of the care taken to segregate different kinds of scrap, mixups are likely to occur. When this occurs a rapid identification test becomes indispensable. Table I¹ summarizes some of the so-called spot tests which are explained below:—

- (1) Nitric acid test : Place 1 or 2 drops of concentrated nitric acid on the clean metal surface. Observe any reaction for 1 to 2 minutes. Then dilute with 3-4 drops of water and observe the reaction. If solution turns green or red, use it for the iron nail test.
- (2) Iron nail test : Rub a clean iron nail in the coloured acid solution in contact with the specimen. If the alloy contains copper, copper will be deposited on the nail or the metal surface.
- (3) Ammonia test : Dissolve a bit of the metal in nitric acid, or attack the surface with a few drops of the acid. Dilute somewhat and add ammonium hydroxide to the solution until the latter is strongly alkaline. If copper or nickel is present a pale blue precipitate will be formed, which on further ammonia addition becomes a dark blue solution.
- (4) Paper test for nickel : Put one drop of a mixture of 10 cc. H_2SO_4 , 10 cc. HNO_3 , 10 cc. H_3PO_4 , 10 gm. citric acid and 25 cc. water, on the metal for 15-30 seconds. Then absorb the drop on a paper test strip. (The test strip is made out of filter paper dipped in a solution of 10 gm. citric acid, 25 cc. water, 10 cc. of 1 per cent. dimethylglyoxime in isopropanol and dried). When potassium hydroxide is dropped on this paper a red colour will form if nickel is present. There is no colour interference from iron or other elements.
- (5) Silver nitrate test : Treat the clean metal surface with a few drops of 2.5 per cent. silver nitrate solution. If tin is present a black deposit with white precipitate will form.

These spot tests are to be applied along with other tests which identify the broad classes of metals and alloys by colour, density, etc.

Reprocessing for Recovery of Metals in the Virgin State

As observed before one of the functions of the secondary metal industry is to reprocess the scrap in order to recover the metals in their original virgin state. This is a costly processing and is carried out only when the scrap is contaminated to such an extent that it cannot be employed directly to make a standard alloy. In other words, when the ratio of the elements present in the scrap or the nature and amount of elements present is such that for all practical purposes the scrap or drosses, skimmings, etc., serve only as raw materials (like ores or concentrates) for recovery of the metals. Hence reprocessing is necessary

- (1) when the metal is oxidized or entrapped in drosses, slags, skimmings, etc.,
- (2) when the impurities present cannot be removed easily, and
- (3) when the ratio of the metals present does not allow the manufacture of standard alloys directly from the scrap,

¹ *Metals and Alloys*, 1942, August, p. 365.

TABLE I

Material	Nitric Acid Test	Iron nail test	Ammonia test	Paper test	Silver nitrate test
Nickel	Reacts slowly; pale green solution.	Negative	Blue	Intense red	
Monel metal	Reacts; greenish-blue solution	Copper plates out	Dark blue	Intense red	
Nickel silver	Reacts; bluish-green solution	Copper plates out	Dark blue	Red, varies in intensity with nickel content.	
Brass	Reacts vigorously; green solution	Copper plates out	Dark blue		
Tin bronze	Reacts vigorously; blue-green solution	Copper plates out	Dark blue		
Aluminium bronze	Reacts vigorously; blue-green solution	Copper plates out	White precipitate; blue solution		
Copper	Reacts vigorously; blue-green solution	Copper plates out	Dark blue		
Aluminium	Soluble		White precipitate		
Magnesium alloy	Soluble		Colourless		
Lead	Soluble		Colourless		
Lead-silver solder	Soluble		Colourless		No precipitate in absence of tin.
Lead-tin solder	Soluble		Colourless		Black deposit with white precipitate.

There is not much difference between the reduction operations employed for the reprocessing of secondary metals and those employed in the conventional methods using ores or concentrates. Cupolas, blast furnaces or reverberatory furnaces are generally employed for these operations and fluxes and reducing agents are used for elimination of impurities. The refining of these metals is also carried out in the conventional ways.

Manufacture of Standard Alloys

The manufacture of standard alloys from scrap is the most important function of the secondary metal industry. In almost all cases, it is necessary to add additional amounts of metals to the scrap composition in order to bring it to a standard specification. However it is not necessary to use virgin metals to bring about this readjustment since the same results can be obtained by adding proportionate amounts of other grades of secondary metals and alloys. The service of a good chemist at this stage is indispensable.*

The types of secondary metals that can be used directly for alloying may consist of such industrial scrap as borings, turnings, clippings, punchings, etc., or obsolete scrap like wire, sheet, rods, pipes, utensils, castings, etc. This scrap must be graded according to its different ultimate use and must be sorted

when different grades are mixed together. Very often scrap has to be cleaned. Iron and steel pieces can be removed by an electromagnet placed under a moving belt over which the scrap is spread. Oil can be removed from borings, turnings, etc., by using an inclined revolving furnace with a gas flame. The oil burns off leaving clean scrap. This can then be directly charged in a melting furnace. In many cases it becomes necessary to shape the scrap for furnace use by shearing, baling, etc.

For chemical analysis of the scrap, proper sampling is essential. Different grades of scrap can be melted separately and analysed, after which different weights of the several grades can be calculated out to make a standard composition. The types of furnaces used can be either electric, gas or oil fired and even coke furnaces can be used. Much of the success of the operation depends upon the furnace temperature and atmosphere. In certain cases fluxes will have to be used not only to get rid of non-metallic impurities but to remove certain undesirable metals which might contaminate the alloy composition.

It must be borne in mind that not only the chemical analysis but also the physical properties of the alloy composition aimed at should conform to a standard specification. After removal of the minute impurities through fluxing and refining, the metal must be sound and uniform in structure. The final success of the operation depends on the melting practice and control of operations by a trained supervisory staff backed by a progressive management. Many instances are available of the management,

* A paper dealing with chemical control in a shop making brass from all-swarf melts, by Pollak and Lellowe has appeared in the *Metal Industry* (6th April and 13th April 1945). This paper deals with preliminary preparation and rapid methods of analysis of different elements for quick adjustment of brass melt compositions, and must prove useful to brass remelters.

having no melting shop experience, interfering with the work of experienced shop superintendents. This works to the detriment of the industry and should be avoided.

So far general points regarding the treatment of secondary metals have been dealt with. The following paragraphs deal with some important metallurgical aspects.

Secondary Brass and Bronze

In this group may be included high-tin, low-copper alloys with very low lead, red brasses, leaded yellow brass, leaded bushings and bearing alloys, manganese bronze, silicon bronze and aluminium bronze.

In general in the manufacture of these alloys, the secondary metal is first sorted, melted and cast separately. These casts are then analysed, a charge for a standard alloy is calculated out, and weighed amounts of the various grades are then melted in a suitable furnace. Air is blown through the melted charge to rid the metal of detrimental impurities or reduce them to specification limits after which they are skimmed off with the aid of a flux. The bath of metal is then poled with wood, chemically tested before and after any additions are made to bring it upto specification and finally poured into ingots or castings, after which a final chemical and physical examination is made. The physical properties of the final product will depend on several factors like :

- (1) pouring temperature,
- (2) melting practice,
- (3) pattern equipment,
- (4) sand conditions,
- (5) gates and risers, etc.

Reliable temperature measuring instruments, sand control, etc., are absolutely essential.

The high-tin, low-lead alloys require no unusual foundry technique. However, in melting this kind of scrap care should be taken to use as little virgin tin and copper as possible which can be done by aiming at a specification which requires slightly lower amounts of tin.

The technique for casting red brasses, leaded bushings and bearing alloys is very much simplified and the castings can withstand considerable pressure. The leaded yellow brasses, however, do not cast very well. The metal is not as fluid as in the case of red brasses and clean castings are difficult to obtain. Zinc fumes are also given off which are a health hazard. These alloys are

now replacing high copper alloys for low-pressure and structural castings.

The manganese and aluminium bronzes have high strength and hardness combined with resistance to sea-water corrosion. Special foundry practices are necessary in casting these alloys because of high shrinkage requiring large risers. Turbulence during pouring should be at a minimum. Silicon bronzes also present some difficulties during casting but not as much as the other bronzes. Great care should be taken to keep the silicon bronzes separated lest they get mixed with leaded bronze alloys where silicon is a harmful impurity.

Secondary Tin and Lead Alloys

The description and class of secondary tin and lead alloys available, along with their approximate composition and possible disposition is given in Table II compiled by G.E. Behr.² India does not produce any tin or lead. Hence the available secondary tin and lead should be used as carefully as possible and melting losses should be kept low.

It is desirable to segregate the different kinds of secondary lead and tin alloys as much as possible in order to avoid undue difficulties during reprocessing. However it is not always possible to be able to buy segregated scrap and for that reason it becomes necessary to refine these secondary metals, i.e., to remove the undesirable metals either by adding another metal with which the undesirable metal alloys preferentially or by means other than those involving the use of added metals.

In cases where another metal is added for refining, there forms an alloy, or inter-metallic compound, of the added metal with the impurity which crystallizes as a crusty layer on the surface of the melt and can be removed easily. A very good example of this method is the Parkes process of desilverizing of softened lead in which zinc is added to form a zinc-silver alloy which is removed and treated for silver recovery.

The other methods of refining depend on the chemical reactivity of the elements to be removed. Oxidation and chlorination are the common means of getting rid of the undesirable elements. The reactions are selective in nature; in other words, those elements which have a higher affinity for oxygen will be oxidized in preference to other elements.

² *Metals Technology*, T.P. No. 1642, October 1943.

TABLE II

General class of secondary metal	Approximate composition	Possible disposition
Jewelry metal	Over 90% Sn + Pb + Sb + Cu	Tin base babbitt by lead removal or solder by Sb and Cu removal.
High-grade babbitt	Over 70% Sn + Pb + Sb + Cu	Same as above.
Solder	Sn and Pb + anything	Solder.
Electrotype metal	3.5% Sn, 3.5% Sb, balance Pb	Antimonial lead by tin removal.
Type metal	3 to 6% Sn, 8 to 15% Sb, balance Pb	Type metals or lead-base babbitt. Antimonial lead by tin removal.
Tinny hard lead		
Lead-base babbitt		
High-tin antimonial lead		
Cable lead	12 to 20% Sn, 10% Sb, balance Pb	Type metals or solder
Scrap lead, sheet and pipe, drosses of the above	2 to 3% Sn	
Battery plates	Very dirty common lead 4% Antimonial lead	Common lead uses Antimonial lead or conversion to soft lead.

In this connection the following table of the heats of formation of metal oxides will be found useful. Those metals whose oxides have a higher heat of formation can be easily removed from an alloy of several metals.

Metal oxides	Heats of formation, cal. per mol for one atom of oxygen.
CaO	151.7
MgO	146.1
Al ₂ O ₃	126.6
Na ₂ O	99.45
ZnO	83.5
SnO ₂	69.05
SnO	67.7
CdO	65.2
FeO	64.3
NiO	58.4
H ₂ O gas	57.8
Sb ₂ O ₃	55.1
PbO	52.46
As ₂ O ₃	51.36
Bi ₂ O ₃	45.7
Cu ₂ O	42.5
TeO ₂	38.8
CuO	35.5
PbO ₂	32.5
Ag ₂ O	6.95
Au ₂ O ₃	3.66

Behr³ gives the following list of the principal refining operations performed on secondary lead, tin and their alloys.

Elements to be removed	Removal reagent
Copper	{ Sulphur Aluminium Oxidation
Zinc	{ Sulphur or sal ammoniac Chlorine Caustic soda Lead chloride
Arsenic	{ Oxidation Zinc Aluminium
Tin	{ Oxidation Caustic soda + an oxidizing agent Chlorine Lead chloride

Elements to be removed	Removal reagent
Antimony	{ Oxidation Aluminium Sodium
Lead	{ Chlorine Sulphur
Iron	{ Aluminium.

The sodium or aluminium remaining in the melt, after refining is complete, can be removed by oxidation, steam, sulphur or sal ammoniac. Poling or steaming is also used for cleaning up the melt.

The choice of the removal reagent needs some thought. Costly reagents should be avoided as far as possible. For instance, in decopperizing with sulphur, one lb. of sulphur will remove about three lbs. of copper and in doing so produce about thirty lbs. of dross depending upon the composition of the metal. Sulphur is not very efficient or economical while aluminium is highly reactive and can be used for the removal of iron, arsenic, copper and antimony from lead and tin alloys. Since iron, arsenic and copper are objectionable elements, and antimony needs to be reduced in most reconversion practice, aluminium is a better refining reagent for solder alloys. Each lb. of aluminium will remove about three to four lbs. of the above elements. If higher amounts of tin are present in the alloy, the action of aluminium is more efficient than when the percentage of tin is low. After adding the aluminium, the melt is stirred and its temperature raised till all the aluminium is melted. The melt is then cooled slowly when a crust forms on the surface which contains all the impurities and is removed.

Zinc, when present, can be removed by selective oxidation after raising the melt to a cherry-red heat. Chlorine can be used to remove zinc but it takes a special apparatus and a long time. Caustic soda though an

³ Loc. cit.

excellent zinc remover should not be used when tin is present unless the tin is also to be removed. Lead chloride can be used to remove zinc, aluminium, sodium or any other metal higher in the chloride series of heats of formation than lead.

Arsenic is not easily removed from lead-tin alloys. The usual method of oxidizing out does not work when tin is present because tin is removed before arsenic. Powdered zinc can be used which also removes copper. Aluminium is not a very selective arsenic remover in the presence of tin and antimony. It should be avoided for arsenic removal as far as possible because of the danger of producing toxic arsenic gas in the presence of nascent hydrogen produced by wet aluminium-arsenic compound.

It is not generally necessary to remove tin from lead-tin alloys. However, tinny hard lead containing 8–15 per cent. antimony can be converted to antimonial lead by tin removal. Molten caustic soda, with steam as an oxidizing agent, is perhaps the best way to remove tin. The processes of tin removal by chlorine and lead chloride are patented in America.

Antimony is best removed by oxidation. However, when tin is present, aluminium should be used in order to conserve tin. Use of metallic sodium for antimony removal is quite novel in that the melt is solidified after addition of sodium and the crust formed on top is dissolved by molten caustic soda which is then ladled off.

Sometimes in contaminated tin-base metal it is necessary to remove lead. This is done by passing chlorine gas. Iron as mentioned above is best removed by aluminium.

Secondary Aluminium

Now that the war is over, large quantities of secondary aluminium have become available. The proper utilization of this material is of great importance in Indian economy because of the high prices of virgin aluminium now prevailing. Aluminium, unlike copper or lead, is very easily oxidized and for that reason it is not possible to refine it by ordinary metallurgical processes. There is, however, the famous Hoops process in which impure aluminium is re-electrolysed to produce 99.99 per cent. pure aluminium. This process being very costly and requiring elaborate apparatus, is out of the question. The best possible way in which secondary aluminium can be utilized is for the manu-

facture of standard alloys if the scrap is properly segregated or for degrading virgin aluminium. Fluxing of the melt with chlorine gas is recommended.

Aluminium alloys can roughly be classified into common or non-heat treatable and heat treatable alloys. These are again divided into cast alloys and wrought alloys. Very broadly, it can be said that alloys containing copper, magnesium and nickel are strong or heat-treatable alloys while those containing manganese, iron or silicon are non-heat-treatable.

In order to promote the increased use of secondary aluminium it is necessary to know what the scrap consists of. If it is segregated scrap of a standard alloy and has not been contaminated, the best way to use it would be by mixing it with primary metal for the production of an alloy of the same composition. The controlling factor in deciding whether scrap or remelted ingots can be used for this purpose is the composition. In case of wrought product the elements to be considered are iron, silicon, zinc, tin and lead which are mostly there as impurities while in casting alloys magnesium also needs consideration along with the other impurities.

The problems that arise out of not segregating the aluminium scrap are so many that it becomes difficult to find a use for such metal. In cases where contamination is not serious, small amounts of this metal may be added in similar alloy melts. Of course, the problems of utilizing such scrap arise only when standard alloys are attempted. In India where almost any kind of aluminium is used by the small utensil manufacturers with complete disregard as to the corrosion resistance, etc., of the final product, and where moderate drawability, spinnability or castability is the only criterion for selection of the metal, utilization of this kind of scrap have presented few problems. In order to identify different aluminium alloys the following spot tests may be used.

Chemicals required

20 per cent. caustic soda solution.

30 per cent. nitric acid.

50 per cent. ammonia solution.

1 per cent. alcoholic solution of dimethylglyoxime.

(i) 20 per cent. *Caustic Soda*. A drop of 20 per cent. caustic soda solution is applied to a cleaned surface of the metal and allowed to react for 3 to 5

minutes. The surplus liquid is then removed with blotting paper and the colour of the resulting stain is observed.

WHITE stain indicates pure aluminium or magnesium alloy.

GREY-BROWN loose stain indicates a high silicon-aluminium alloy.

BLACK adherent stain indicates either Duralumin or Hiduminium R: R: type alloy.

- (ii) 30 per cent. Nitric Acid.—One drop of 30 per cent. nitric acid is then added to any coloured stain produced by the caustic soda solution. If complete solution of the stain does not take place, a high silicon content is indicated.

- (iii) 50 per cent. Ammonia Solution.—Two drops of a 50 per cent. ammonia solution are added to the drop of acid whatever may have been the action of the latter on the original stain.

BLUE colour formation indicates the presence of copper in alloying quantities.

- (iv) 1 per cent. Alcoholic Solution of Dimethyl glyoxime.—Finally one drop of a 1 per cent. alcoholic solution of dimethylglyoxime is added.

Brilliant RED colour spreading over the spot in 1 minute shows the presence of appreciable quantities of nickel.

Faint RED edge to the spot merely indicates a trace of nickel as an impurity.

Secondary Magnesium

All the remarks about segregating secondary aluminium also apply to secondary magnesium. The variety of magnesium alloys are very few and the majority of both cast and wrought magnesium alloys contain aluminium, magnesium and zinc. Magnesium requires great care in handling and under

no circumstances wet scrap should be stored shipped or recovered because of the danger, of hydrogen evolution leading to spontaneous combustion. Magnesium base alloys are easily identified by a silver nitrate spot test. The silver nitrate turns jet black on magnesium and remains colourless on aluminium. Magnesium scrap is not generally baled because of the lower magnesium recovery on baled magnesium. Copper, silicon, iron and nickel are harmful impurities in magnesium and care should be taken not to contaminate the scrap with these materials.

The melting and casting of magnesium require special precautions. Melting is generally done in cast iron pots and gas or oil is used as fuel. Fluxes with magnesium chloride base with other halide salts are added both for refining and protective action. After melting is completed the metal is raised to a temperature of 800 to 900° C. before casting. Unlike aluminium the higher temperature refines the magnesium grains. Sulphur is used as a protective flux while pouring magnesium alloys. In cases where a magnesium fire breaks out great care should be taken not to use water or any other extinguishers except those specially recommended to extinguish magnesium fires. These recommended extinguishers should be kept handy and the workmen instructed in their use.

In conclusion, it must be said that in India, a secondary metal industry is as important as starting new non-ferrous metal industries. India is lacking in workable ore deposits of most of the non-ferrous metals, and before the war most of her requirements of non-ferrous metals were met by imports. The present war has brought home the need of a sizable metal industry in India. Every lb. of lead, tin, copper or other metal salvaged will add to the self-sufficiency of the country. However, all such salvaging must be done under expert metallurgical advice to avoid waste.

FOOD YEAST, ITS IMPORTANCE AND MANUFACTURE

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THE manufacture of compressed yeast was started in the last century. There is evidence that compressed yeast was available as early as 1781, though it was only in 1792 that Mason, an Englishman, first manufactured it on a commercial scale. Its manufacture in Germany was started soon after that date. Mention may be made of some of the pioneers who undertook an extensive study of yeast in those early years. They were Kruntz, Hermstadt, Benno Scharl, Riem, Pistonis, Dorn, Fremy, Boutron, Thiele, Tehenhoff, Ludendroff, Otto, Balling, Stammer and Mantner. Later, the researches of Pasteur and Hansen's method of single spore culture laid the foundation of yeast manufacture. Towards the end of last century, the yeast industry began to make rapid progress in Holland and Germany. A Vienna process was developed for the manufacture of yeast from grains in Holland near about 1860, and aeration of mashes was introduced by Marquerdt in 1879, which resulted in the rapid growth of the organism. In England, the regular manufacture of yeast was started in 1886^{1, 2}. Before the last World War, the quantity manufactured was not enough to meet the requirements and as much as 14,664 tons had to be imported per annum.

The last Great War of 1914-19 saw another phase in the yeast industry. In Germany there was an acute shortage of food due to the British blockade and they turned to explore new sources of food such as yeast. High costs and scarcity of grain, however, stimulated research on yeast manufacture from materials other than grains. At the same time it became essential to provide nitrogenous foodstuffs for horses and cattle, about 5,000,000 tons of which were being imported prior to the war³. The researches of Pasteur, Ducleaux, and later of Marker⁴ had indicated that proteins could be synthesized by yeast from inorganic nitrogen and carbohydrate sources. Delbrück⁵ attempted its production on a commercial scale from beet molasses but the yields were very low. Hayd-uck⁶ succeeded in 1915 in adopting Delbrück's process for producing yeast on a commercial

scale. A special strain of yeast, *Torula utilis*, was developed under the inspiration of the *Institute of Brewing, Berlin*, which was capable of vigorous growth with no alcohol production. An interesting account of their process will be found in the reports on "Makeshift industries in Germany"⁷. Before the war there were 502 factories in Germany, manufacturing yeast and 10 new ones were put up during the war, as compared to a total of 20 in the United States of America.

In England also, the yeast industry received an impetus in the last war. In 1914, the import of yeast declined to 200 tons per week and during 1915-17 it was still more restricted, while during 1918 it was prohibited. When the prohibition was lifted in 1919, the import was only 70 tons per week. The home production during the prohibition period rose from 400 tons per week to 650-700 tons per week. Before the war, the price was 19s. per 36-lb. bag, which shot up to 39s. per 36-lb. bag in 1914.

The recent World War has given a still greater impetus to the yeast industry. It is reported that the production of yeast in Germany had increased many-fold during the war and some thousands of tons of yeast per year were being manufactured and consumed. Germans were growing yeast on wood sugar manufactured by the expensive process of acid hydrolysis of wood.

The importance of yeast is due to the fact that it contains as much as 56 per cent. protein of high biological value in an easily assimilable form. The digestibility of the mineral yeast was assessed by Voltz⁸ (1915), who found it to be of a high order. None of the belligerent nations in the recent World War found themselves capable of supplying the protein requirements of their populations. It became imperative, therefore, to develop methods for the large-scale production of protein for animal and human feeding, either along the lines adopted in Germany during the last war, or by other methods which might be found superior. In Great Britain, at the request of the Agricultural Council and the Scientific Committee on Food

Policy, this work was undertaken by the *Department of Scientific and Industrial Research* in the Microbiological Section of the Chemical Research Laboratory at Teddington. A better strain of *Torula utilis* was developed, capable of easy and vigorous growth without any alcohol production. For use in tropical countries, special strains of yeast were developed by Thaysen⁹, as it was found that in order to maintain the low temperature necessary for the growth of *Torula*, expensive cooling equipment had to be installed. *Torulopsis utilis* Var. *Thermophilis* and *Major* are capable of growing at a comparatively higher temperature and are of a much bigger size. Also a special method was worked out for the production of food or mineral yeast which was capable of giving much greater yields. Following this work, a yeast factory controlled by the Government, was set up in Jamaica at a cost of £150,000, with a manufacturing capacity of 2,250 tons of yeast per year; it is estimated that yeast would be available at a cost not exceeding 6d. per pound^{10(a)}.

During the early years of World War II, the adequate feeding of Allied Armies stationed in India in large numbers began to present difficulties. It was becoming so in every other part of the British Empire largely due to the shipping position. The Government in Britain became keen on establishing yeast factories in the United Kingdom. The Government of India, Department of Supply, New Delhi, set up in 1941 a Food Yeast Committee to investigate into the possibility of yeast manufacture in India from molasses. Two processes were considered: (1) Dr. Weizmann's process and (2) the Teddington Process. The committee recommended the possibility of manufacturing 10,000 tons of yeast in India per annum. With the easing of the war situation, however, the entire plan was dropped. More recently, the Government of India, Department of Food, took up the question of yeast manufacture for post-war civil needs. It is understood that plans have been prepared to set up one Government factory which will produce 2,000 tons of yeast per annum.

Nutritive Value of Yeast

Extensive investigations have been carried out on the nutritive value of yeast during the last three decades. These studies were stimulated by the circumstance that increasingly large quantities of yeast waste were being thrown out by the rapidly growing

brewing plants of Europe and America, and its disposal was becoming a problem. Some of the analytical data on yeast is summarized in Tables I to VI which also indicate the nutritive value of yeast.

TABLE I. *Analysis of Waste Yeast from Beer Manufacture*¹⁰.

	Per cent. on dry weight	Per cent. on wet weight
Proteins	52.41	14.15
Glycogen	30.25	8.16
Cellulose gum	6.88	1.87
Fat	1.72	0.46
Ash	8.74	2.36
Water	0.00	73.00

TABLE II. *Composition (%) of Food Yeast and Other Proteinous Foods with Respect to Certain Important Amino Acids*¹¹.

Amino acids	Yeast	Ox muscle	Eggs	Hali but muscle	Milk	Whole flour	Whole wheat	Potatoes
Lysine	9.0	9.6	5.0	7.5	6.7	1.2	2.5	3.2
Histidine	2.4	1.8	1.4	2.6	1.8	1.6	2.0	2.3
Arginine	5.5	7.5	5.4	6.3	3.8	3.8	5.5	4.9
Cystine	2.2	1.6	1.3	..	0.5	1.9	1.9	4.3
Tryptophane	1.3	1.3	1.3	..	2.3	1.4	1.4	..
Tyrosine	6.0	2.2	3.2	2.4	4.2	3.9	3.9	4.0

TABLE III. *Analysis of the Ash of Yeast*¹².
% in ash

Constituents	Top yeast	Baker's yeast
P ₂ O ₅	52.3	54.5
K ₂ O	35.4	36.5
Na ₂ O	0.06	0.7
MgO	4.8	5.2
CaO	1.156	1.4
SiO ₂	1.1	1.2
SO ₃	0.41	0.5
Cl	..	Trace
FeO	0.43	Trace

TABLE IV. *Phosphorus Compounds of English Brewer's Yeast*¹³.

Compound	mg. P. per gm. of yeast
Total phosphorus	3.25
Ortho-phosphates	1.37
Pyro-phosphate	0.68
Organic phosphorus	1.17
Hexose-di-phosphate	0.38
Hexosemonophosphate	0.72
Nucleic acid	0.07

TABLE V. *Composition of Yeast Fat*¹⁴.

	%
Glycerol	5.3
Volatile acids	5.2
Palmitic acid	9.5
Stearic acid	5.9
Oleic acid	47.6
Dioleic acid	2.9
Unsaponifiable substances	16.6*

* Out of which 3.3 are the sterols, ergosterol, cryptosterol.

TABLE VI. *Vitamins of Yeast*¹⁵.

(Analysis of a typical sample)

	μ gm./gm.
Thiamin	700
Riboflavin	62
Nicotinic acid	550
Inositol	3800
Biotin	2.6
Pantothenic acid as Ca salt	164
Pyridoxin	40

TABLE VII. Comparative Nutritive Value of Food Yeast and a Number of Other Important Foods.

Foodstuffs	Water	Protein	Fat	Carbohy- drates	Calories per 100 gm.	Calcium mgm. per 100 gm.	Iron mgm. per gm.	Vit. A I.U. per 100 gm.	Vit. B, mgm. per 100 gm.	Ribo- flavin, mgm. per 100 gm.	Nicotinic acid mgm. per 100 gm.
	%	%	%	%							
Food yeast	8	43.1	2.4	3.0	206	127	20	0	2	5	40-50
Brewer's yeast	5	50	1	...	...	80	20	0	16	4	30-40
Baker's yeast	5	45	2	...	...	40	25	0	3	7	30-40
Whole milk	88	3.3	3.6	4.4	63	120	0.1	70-140	0.05	0-15	3
Dried whole milk	4	25.6	26.7	35.6	485	895	0.8	1,070	0.3	1.15	24
Dried skim milk	5	35.8	0.7	47.9	341	1,225	1.0	1,300	0.32	1.6	30
Cheese	37	24.9	34.5	0	410	810	0.6	1,300	0.03	0.5	...
Eggs	74	12.5	11.5	0.9	157	60	3.0	1,000	0.15	0.4	3
Mutton	64	16.0	19.0	0	235	10	2.0	50	0.16	...	...
Beef	69	19.0	10.0	0	166	10	4.0	50	0.08	0.25	43
Liver	70	17.0	6.0	5.0	142	10	13.9	1,500	0.4	3	170
Cod	81	16.0	0.5	0	69	25	1.0	0	0.06	...	30
Dried peas	7	24.5	0	50.0	298	61	4.7	200	0.45	0.3	18
Haricot beans	8	21.4	0	41.0	250	180	6.7	0	0.45	0.3	0
Cabbage	92	1.5	0	5.0	26	55	1.0	900	0.08	0.05	3

Table I shows that yeast contains as much as 52.41 per cent. of protein. Scientific investigations have indicated that yeast protein is superior to any vegetable protein, and is in every way comparable to animal protein. Table II shows that yeast is a very rich source of the more important amino acids and, qualitatively, its protein is comparable to some of the first class proteins from other sources. The ash of yeast is rich in the minerals potassium and phosphorus, and contains phosphorus compounds of high nutritive value (Table IV). The fat of yeast is quite suitable as food (Table V). In addition to its high protein, fat and mineral salts content, yeast is one of the richest single source of several important vitamins. It contains large quantities of thiamin, riboflavin, nicotinic acid, provitamin D, pantothenic acid, biotin and *p*-aminobenzoic acid. Strains have been developed which are exceedingly potent in vitamins. Table VI shows the analysis of a typical sample and shows its extraordinary potency in some of the more important factors of the vitamin B-complex.

Yeast contains 0.56 gms. of ergosterol or provitamin D per 100 gms. of dry substance, 33 per cent. of which gets converted to vitamin D on irradiation with ultraviolet light of 280-300 μ wave length in layers of 0.1-0.5 mm. thickness for 30 minutes¹⁶. On an average, values of more than 400 I.U. of vitamin D per gram have been recorded.

Nutritionally, therefore, yeast can be regarded as a combination of high class proteins and vitamins *par excellence*. The comparative nutritive value of yeast with other foodstuffs is shown in Table VII ^{10(a)}.

Uses

There is a vast amount of published literature on the medicinal uses of yeast ^{17,32}. On account of its high nutritional value yeast has been recommended, and has been extensively used in military rations of the European armies in the war that has recently ended. In Britain surplus of brewer's yeast is debittered and made into a large number of products. By digestion with proteolytic enzymes, yeast concentrates have been prepared, which exactly resemble meat concentrates in flavour and nutritive value, and, in addition, are much more rich in vitamins. *Marmite*, *vegamite*, *thiamax*, etc., are some of the trade names under which such products are finding a universal appeal to the European palate and are being used in the making of gravies and soups. Lot of work has been undertaken on the study of the effect of addition of moderate quantities of yeast to white flour by Schwarz and co-workers leading to the enrichment of bread with vitamins of the B group. Their main findings³³ are shown in Fig. 1. During the last war the incorporation of yeast with flour was prohibited by the German Government because as much as 3 per cent. of flour is destroyed by being changed into CO₂ and alcohol which escape during the baking of bread. When it was established that the nutritive value of bread made from yeast increased many-fold and the 3 per cent. loss compared to the increase in food value was insignificant, the consumption of yeast rose 300-fold in Germany alone.

Roscoe³⁴ made observations on the bread made from baking powders and found very little or no trace of vitamin B₁ activity,

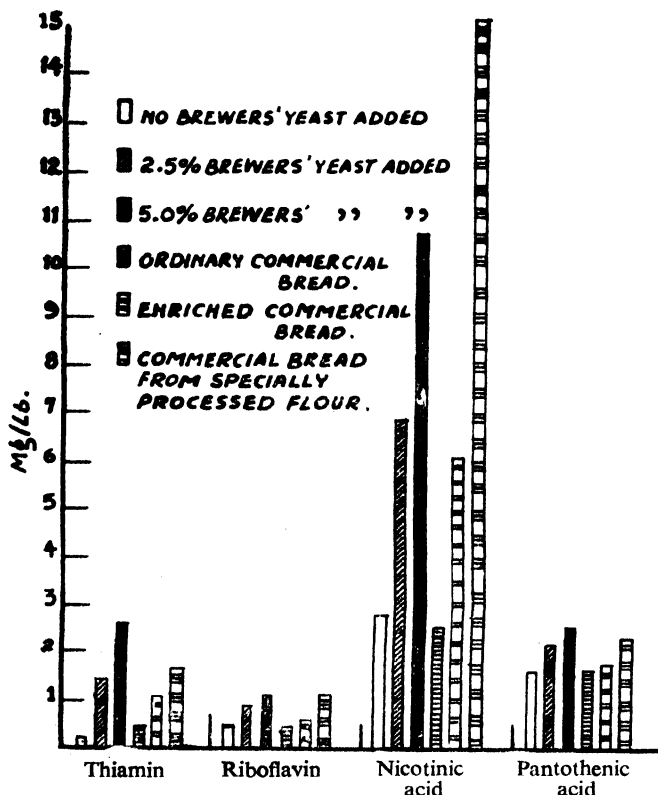


Fig. 1 Vitamin content of different kinds of bread

though the flour from which the bread had been made was definitely rich in vitamin B₁. On the other hand, bread made with yeast contained more vitamin B₁ than could be possibly accounted for by the wheat itself. It has been found that bread made from yeast was richer in nutritive elements compared to bread raised with inorganic salts. Morgan and Fredrick³⁵, Scheunert and Schielblich³⁶ observed that yeast stabilizes, if it does not contribute vitamins to the bread and increases its protein content. In view of these facts, Stone³⁷ recommended the incorporation of yeast in the daily rations of the British and American forces.

The military demand for yeast rations to the armies has stimulated research on the production of yeast in India and other parts of the British Empire. There is an economic aspect also, namely, the utilization of colonial raw materials whose normal markets have been cut off. Molasses, a waste product of the sugar industry, is one of such products. Before the war, molasses was produced in surplus quantities and its

profitable utilization was of considerable interest to sugar manufacturers.

Raw Materials for Manufacture

The chief raw materials are:—

- (i) carbohydrates such as molasses, barley, maize, wheat and tapioca.
- (ii) chemicals such as calcium superphosphate, ammonium sulphate, ammonia and sulphuric acid.

In this country there is no dearth of carbohydrate raw materials. As regards chemicals, India is producing sufficient quantities of calcium superphosphate, sulphuric acid and sodium hydroxide. This country lacks ammonium sulphate, though at least two factories are under contemplation for the manufacture of this product in India. At present the *Imperial Chemical Industries* are the chief suppliers of this chemical.

Manufacture of Yeast

The following are the methods used in the commercial production of yeast³⁸:—

(a) *Vienna Process*.—This is a modified form of brewing operation and was developed in 1860. In this process, yeast is cultivated on mash obtained from a mixture of malt, rye and wheat. The mash of 15–20° balling are soured with lactic acid bacteria which help in adjusting the acidity to 1.5 per cent. The soured mash is sterilized, chilled and pitched with yeast. The fermentation is carried out at 30°C. and the temperature is maintained at that level, by circulation of cold water. Vigorous aeration is carried out throughout the process. After 28 hours, the mash is chilled, and the yeast centrifuged and filter pressed. On an average, yields of 90 per cent. on the weight of sugar, when 50 per cent. of the sugar is present in the raw material are recorded.

(b) *Molasses Ammonia Process*.—The Molasses Ammonia process or the Hayduck process is at present the most widely used method for the manufacture of compressed yeast. As a source of carbohydrates, assimilable sugars of molasses are used and nitrogen is supplied in the form of ammonium salts,

while the phosphorus requirement is made up by the addition of phosphates which, besides supplying phosphorus for the synthesis of nucleo proteins, act as buffers. Proper maintenance of temperature, of pH, and vigorous aeration are essential to obtain proper yields.

The molasses solution is filtered to get a clear wort and the pH, adjusted to 4.5. The starter or seed yeast is carefully prepared from the selected strain. In this process very dilute worts are used in the beginning, the concentrated wort is continuously added at such a rate that any alcohol that may be formed is assimilated during the growth of yeast.

The following factors are controlled during fermentation:— pH, near about 4.5 with NH_3 or H_2SO_4 ; nutrients added in proportion to the rate of growth of yeast; aeration of worts with sterile air; concentration of available sugar by differential addition; control of temperature.

When the growth is completed, yeast is separated from the wort by filtration or centrifugation, washed and pressed. Flour may be added to yeast to facilitate handling, yields of 200 per cent. on wet basis, and 40–50 per cent. on dry basis, on the weight of glucose have been recorded.

(c) *Heijkenstjold's Process*.—In this process sulphite liquors from cellulose factories mixed with a small amount of molasses serve as the source of carbohydrates. The hot sulphite liquor is adjusted to a pH, of 6.0–6.5 with lime, powdered limestone and sodium carbonate while the liquor is being aerated in tanks. The precipitates which collect in the neutralized solution are separated, and the clear supernatant liquor, decanted and cooled to 28–30°C. serves as the medium for the culture of yeast. The initial sugar concentration is 3–5 per cent. Sometimes, malt sprouts are added. The mash is now inoculated with yeast and the sulphite liquor is fed into the mash after yeast has commenced to develop new cells; the required ammonium salts are also added. Vigorous aeration is continued throughout the fermentation. The yeast obtained by this process is of high purity and of light colour. Yields of 160 per cent. of fresh yeast on the basis of fermentable sugars have been obtained.

(d) *Fodder Yeast from Wood Sugar*.—Germany lacks molasses and grain carbohydrate sources, and cannot spare any of them for the manufacture of yeast. This has resulted in the production of yeast from

wood sugar. The dilute sugar solution is prepared from wood by Scholler Fornesch process and fortified by the addition of nitrogen, phosphorus and potassium in the form of salts. Aeration, pH, and temperature are controlled as in other processes and yields of 50 per cent. (dry wt.) on the basis of sugar fermented, or 25 per cent. on the basis of wood substance are recorded.

Market for Yeast in India

In India, the problem of food supply is very acute. Recently the prices of foodstuffs and the general cost of living have gone up many-fold. Even in the so-called surplus areas, properly balanced diets are becoming costlier than what an average person can afford, and this is resulting in the decrease of vitality, stamina and resistance to disease. The nutritive value of food is chiefly dependent upon proteins of high biological value, vitamins and essential minerals. While meat is rich in proteins of high biological value, the vegetarian diet lacks good quality proteins and must be supplemented from other sources to come up to adequate dietetic standards. As many as 75 per cent. of the Indians are vegetarians. The meagre income which is available to an average Indian does not allow the supplementing of his diet with milk protein. A great deficiency of milk is already being felt and is likely to have grave consequences for the vegetarian population. Since yeast protein is comparable with animal protein, it can serve as a source of first class protein for the vegetarian.

Meat and other sources of animal proteins are in short supply in all the war devastated countries, Eastern and Western. It will take several years before the herds of cattle destroyed in the war-ravaged countries will be replaced and the aggregate output of meat and milk are brought to normal-time levels. Yeast can, therefore, play an important part, and large quantities of food yeast will be needed for incorporation with the diet of the people. The value of yeast protein is well recognized. India, if it has a yeast industry, can even export yeast in large quantities.

The production of protein in the form of meat takes years as compared to the production of the same amount in the form of yeast which takes only weeks. The carbohydrates in the form of cane, beet, barley, etc., have to be raised in sufficient quantities during their seasons for the whole year's

production of yeast. It is interesting to note that an acre of land under carbohydrate cultivation will yield 85 lbs. of yeast protein compared to 7 lbs. of meat or milk protein during the same time. The vitamins obtained in the case of yeast production will be in large quantities, and bear no comparison at all with those obtained in meat production. Yeast is very cheap compared to animal proteins because it can be manufactured at less than 6 annas a lb.

Figures are not available on the consumption, or import of yeast in India. Some foreign packed dry yeast is available for medicinal purposes in the market. In other countries the yeast industry is well established. As far back as 1910 one of the largest yeast manufacturing concerns in the world, Hebbing of Hamburg, produced 2,500 tons of compressed yeast yearly. During 1919 another concern, Dessaner Zuckerraffiner G.m.b.H., was daily producing 190,000 kgms. of yeast, 50 per cent. more than the total production of yeast in the U.S.A., in one day during that period. The export and import trade of yeast in the U.S.A. is given in Table VIII.

TABLE VIII.

	Export during 1930-32 dollars	Import during 1930-32 lbs.	Dollars
1930	677,025	253,730	51,164
1931	559,954	1,114,891	165,194
1932	497,815	1,287,565	137,167

It is estimated that until lately the output of yeast in Germany was more than 400,000 tons, in the U.S.A. more than 115,000 tons and in England more than 2,200 tons per year, while in India it cannot be more than a few tons per year and that also was developed quite recently as a by-product of certain breweries.

It is expected that if yeast factories are established in India, they will be able to compete with any foreign product. The demand for the supply of yeast will be steady and constant, once Indian opinion is educated to its nutritive value. One ounce of yeast in terms of protein is equal to 5 ozs. of eggs, 3 ozs. of mutton, 16 ozs. milk and 4 ozs. wheat. The market for yeast can also be extended because it can be used in the production of glycerol, fat, plastics, for sewage disposal and for other purposes.

The specific problems connected with the establishment of a yeast industry in India will be discussed in a subsequent article.

References

- 1 Frey, C. N., *Ind. Eng. Chem.*, 1930, **22**, 1154.
- 2 Thaysen, A. C., *Nature*, 1943, **151**, 406.
- 3 Arnstein, H., *Utilization of Molasses*, Louisiana Planter and Sugar Manufacture Co., U.S.A., 1925.
- 4 Marker, *Handbuch der Spiritus Fabrikstroup*, 1877, p. 480.
- 5 Delbrück, C. R., Hayduck, F. and Wustonfeld, H., *Jahrbuch des vereins der spiritus Fabrikanten in Deutschland*, 1910, p. 25.
- 6 Hayduck, F., *Z. Spiritusindustrie*, 1915, **38**, 161.
- 7 *J. Soc. Chem. Ind.*, 1917, **36**, 326.
- 8 Voltz, W., *Z. Spiritusindustrie*, 1915, **38**, 235.
- 9 Thaysen, A. C., and Morris, M., *Nature*, 1943, **152**, 526.
- 10 Allen, P. W., *Industrial Fermentations*, Chem. Cat. Co., N.Y., 1926, p. 315.
- 10(a) *Food Yeast, a Venture in Practical Nutrition*, Collonial Food Yeast Ltd., England, 1944, p. 10.
- 11 *Food Yeast Committee Report*, Manager, Govt. of India Press, New Delhi, 1941.
- 12 Tauber, H., *Industrial Enzyme Technology*, Chapman & Hall, 1945.
- 13 Boyland, E., *Biochem. J.*, 1930, **24**, 350.
- 14 Taufel, K., Thaler, H. and Schreyegg, H., *Z. Huntersuch Lebensm*, 1936, **72**, 394.
- 15 Frey, C. N., Private Communication, 1944.
- 16 Schulein, J., *Die Bierhefe als Heil-, Nähr und Futtermittel*, T. Steinkopf, Dresden, 1935.
- 17 Hoobler, B. R., *J. Am. Med. Ass.*, 1928, **31**, 307.
- 18 Dennett, R. H., *J. Am. Med. Ass.*, 1929, **92**, 769.
- 19 Macy, I. C., Outhouse, J., Graham, A., & Long, M. L., *J. Biol. Chem.*, 1927, **73**, 183.
- 20 Hunt, C. H., and Krauss, W. E., *J. Biol. Chem.*, 1927, **73**, 189.
- 21 Aykroyd, W. R., and Roscoe, M. H., *Biochem. J.*, 1929, **23**, 483.
- 22 Murlin, J. R. and Mattil, H. A., *Am. J. Physiol.*, 1923, **64**, 275.
- 23 McLeod, J. C. and Ravenel, L. J., *J. South Carolina Med. Ass.*, 1938, **34**, 37.
- 24 Maisin, J., Pourbaix, Y., and Caeymaes, P., *Comp. rend. soc. biol.*, 1938, **127**, 1477.
- 25 Ando, K., *Gann.*, 1938, **32**, 252.
- 26 Sugiura, K., and Rhoads, C. P., *Cancer Research*, 1941, **1**, 3.
- 27 Kensler, C. J., Sugiura, K., Young, N. F., Halter C. R. and Rhoads, C. P., *Science*, 1941, **93**, 308.
- 28 Lewisohn, R., Leuchtenberger, C., Leuchtenberger, R., Laszlo, D., and Bloch, K., *Science*, 1941, **94**, 70.
- 29 Nasset, E. S., Pierce, H. B., and Murlin, J. R., *J. Lab. Clin. Med.*, 1931, **16**, 12.
- 30 Stephenson, W., Penton, C., and Korenchevsky, V., *Brit. Med. J.*, 1941, **ii**, 839.
- 31 Macrea T. F., El-Sadre, M. M., and Sellers, K. C., *Biochem. J.*, 1942, **36**, 460.
- 32 Kay, H. D., *Unpublished Reports*.
- 33 Schwarz, R., Laufer, S., Laufer, L., and Brenner, M. W., *Ind. Eng. Chem.*, 1942, **34**, 480.
- 34 Roscoe, M. H., *Biochem. J.*, 1930, **25**, 2057.
- 35 Morgan, A. F., and Frederick, H., *Cereal. Chem.*, 1935, **12**, 411.
- 36 Scheunert, A., and Schieblich, M., *Biochem. Z.*, 1928, **202**, 380; 1929, **212**, 80.
- 37 Stone, M., *Amer. Brewer*, 1942, **75**, 38.
- 38 Prescott, S. B., and Dunn C. G., *Industrial Microbiology*, McGraw Hill Co., N.Y., 1940, p. 150.



COAL IN INDIA*

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Introduction

BY the word coal we understand a vast number of organic substances, mostly hydrocarbons, which are very much unlike each other in their chemical and physical characteristics and belong to various geological ages. On a strict geological definition, coal should be regarded as a rock, though according to Mining Rules in India it is a major "mineral." Scientifically speaking, a "mineral" is a homogeneous body which takes part in the architecture of the earth's crust (Niggli). But coal is not homogeneous; it is a heterogeneous substance; a mixture of dried up gels of many hydrocarbons. It is more a sedimentary rock like sandstone, consisting of various substances (mostly hydrocarbons) all of which are, however, amorphous. The coals of the Barakar and the Raniganj series of both Raniganj and Jharia coalfields possess stratified appearance of a sedimentary rock.

Coal is the most important of all the minerals that we have yet learnt to use. Coal mining is the oldest and at the same time the most important branch of mining art, so far as Great Britain is concerned. The annual world output of coal is about 1,200 million tons, of which U.S.A. produces 50 per cent., and of the rest of the world production, 40 per cent. is mined in Great Britain and 40 per cent. in Germany. India's humble contribution is only about 25 million tons, i.e., roughly 2 per cent. of the world production (for consumption of coal per head of population see Table V).

At about 371 B.C. Theophrastes, a pupil of Aristotle, introduced the word coal in his "Treatise on Stones" mentioning that fossil substances "that are called coals, kindle and burn like wood coals." These substances were found in Liguria and Elis on the way to Olympus; they were used by the local smiths¹. The word coal was

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in use before the birth of the term geology which was introduced for the first time by the Swiss scientist, H. B. de Sanssure, in the year 1779². Formerly "coal" was written as "cole" and generally meant any substance that could be used as a fuel. For a long period "cole" simply meant "charcoal." In England coal was known as early as the ninth century. A company obtained a charter from King Henry III in 1239 to work coal in Newcastle. Coal was used in England in Shrophshire during the Romans.

It is certain that coal was known to the Indians before the advent of British rule in India. The presence of an ancient temple at Ekra and village names in Sanskrit and Persian like Angarpathar (deformation of the Sanskrit word Angar Prastar, meaning charcoal stone; Angar meaning charcoal and Prastar meaning stone) and Kankani (a Persian word meaning mining) in the Jharia coalfield, an aboriginal country, prove beyond doubt, that coal mining was known both to the Hindu and Mohamadan rulers³. But it is sure that coal mining was not known in very ancient India. Although the immortal Chanakya Pandit (his other names are Kautilya and Vishnugupta) mentions the presence in India of almost all the minerals including even petroleum, known to us to-day, he does not say anything about coal in his famous Artha-shastra (Book II, Chapter XII).

The modern coal-mining industry in India starts with the Governor-Generalship of Warren Hastings during whose time Messrs. Sumner and Heatley (1774) obtained the first permission to carry out coal mining at Chinaguri near Dishergarh. At that time coal used to be sent to Calcutta by boats from Raniganj to Amta and thence to Calcutta by bullock cart. From 1845 coal began to be transported by rail from Raniganj. Thus, the most ancient coal-mining area in India is the Raniganj Coalfield first mentioned in 1774. The Jharia Coalfield was opened by Mr. Tellemucha in 1777. In the same year the iron ore deposit of the Raniganj field was known.

Chemical Properties

Coal consists mostly of carbon; hydrogen is the next important constituent of coal. Carbon and hydrogen together form the hydrocarbons which constitute the *combustible matter* of coal. N, O, S, Si, P, Ca, K, Na, and many other elements are present

in coal. On burning, those constituents which partly volatilise away at relatively low temperature are called the *volatile components* of coal, the carbon burns at a relatively high temperature; what is left behind is *ash*.

Hydrogen is united partly with oxygen to form water and the moisture of coal. Coal being a colloidal substance, a certain amount of moisture is always present in coal. Hydrogen also combines with nitrogen present in coal to form *ammonia*.

The *nitrogen* content of coal is partly due to the original albuminous constituent of the wood itself but it is mostly due to animals, especially bacteria, which lived in the gradually disintegrating sapproel and perished with it.

Phosphorus has also more or less a similar origin in coal as nitrogen. High phosphorus content of coal precludes the possibility of making pig iron suitable for the acid steel process. The pig iron usually produced in our country contains about 0.4 per cent. P; less than 0.05 per cent. S; less than 1 per cent. Si and up to 1 per cent. Mn; this is utilised in making open hearth steel.

Sulphur is the most undesirable impurity of coal. Coal containing more than 1 per cent. S cannot be used for iron making as it causes a type of brittleness known as *red-shortness*; if used for steam raising it often clinkers very badly. Like phosphorus it is the other most harmful impurity of coke used for metallurgical purposes. Sulphur can be present in any of the following four forms in coal:—

- (1) As sulphides.
- (2) As organically combined sulphur.
- (3) As sulphates.
- (4) As natural sulphur.

Most of the sulphur in coal occurs, however, as metallic sulphide, marcasite, FeS_2 , a dimorphous form of pyrite. It occurs along the stratification and joints and cracks of coal seams. In fact, sometimes the marcasite particles are so minute that they are absolutely invisible to the naked eye; their identity can then be revealed only under the microscope or in the X-ray photograph of coal. The origin of marcasite in coal is due to the reaction between the circulating water containing ferrous sulphate, and the coal. During this reaction reduction takes place and sulphide of iron is set free. Some of the Tertiary coals of India, though very poor in ash, are of low value

on account of their high sulphur contents. Following are the sulphur contents of some of the Tertiary coals of India :—

Ledo	..	Sulphur, 3.06% (ash 0.81 per cent calorific value 8,111);
Tikak	..	2.35% (ash 1.86 per cent. calorific value 8,112);
Khost	..	4.08% (ash 5.88 percent.)
Makerwal	..	5.00% (ash as low as 4 per cent but usually 7 per cent.)

The combined sulphur of coal, i.e., sulphur due to the original sulphur content of the wood, varies between 0.1 and 0.9 per cent. Coals possessing high percentages of pyrite and rich in volatile constituents are liable to spontaneous combustion.

Ash contents of coals.—Most of the ash in the coal is due to impurities added to the coal after and during its deposition and only a very small amount is due to the ash of the original wood, i.e., *inherent ash*. Thus, the ash contents of coal are very variable. Good coals contain 2—3 per cent. ash; the ash content of the anthracitic coal of Brolfa Methyr mine (South Wales) is only 0.3 per cent. In India the Tertiary coals of Assam are low in ash—sometimes as low as 0.39 per cent. The following are examples of a few low-ash Tertiary coals of India :—

Wakching coal	..	Assam	%
Borjan coal	..	..	0.39
Namdang coal	..	..	1.32
Makerwal coal	..	Punjab	1.21
Dandot coal	..	..	3.9
Palana coal	..	Rajputana	9.89
Baluchistan coal	..	....	4.4
			2.18

The average ash contents of some of the important Gondwana coals are as follows :—

	%
1. Raniganj series coal, Jharia coalfield	14
2. Barakar series coal, Jharia coalfield	16
3. 14 Seam coal, Jharia coalfield	9 to 14
4. Raniganj series coal, Raniganj coalfield	13*
5. Barakar series coal, Raniganj coalfield	15
6. Dishergarh seam coal, Raniganj coalfield	11*
7. Ponihati seam coal, Raniganj coalfield	9*

* High in moisture

The main constituents of the ash are SiO_2 and Al_2O_3 almost in equal proportions and next in abundance come Fe_2O_3 , CaO , MgO , P_2O_5 and alkalis. On rare occasions the ash also contains many useful substances like Cu, Zn, Pb and even gold. For instance, in a mine called Cambrian, Wyoming, U.S.A., there is sometimes up to Rs. 6 worth of gold (at Rs. 24 per tola) in the ash of a ton of coal, and the ash of a coal in Argentina contained 38.2 per cent. vanadium.

Usually the relations between ash content moisture, etc., and the coking property of coal are as follows :—

More ash—less coking property.

More volatile constituents—more coking property.

More moisture—less coking property.

The relation between ash content and calorific value has been discussed under “Calorific value of coal.”

Moisture.—Coal is a hygroscopic colloidal substance; therefore, no coal is free from moisture. The moisture content of coal usually varies between 2 and 7.5 per cent. The Raniganj series coals usually contain more moisture than the average Barakar series coals. This is due to the greater depth of the Barakar series coal seams and the greater pressure to which they were consequently subjected. Following are the average moisture contents of the coals of the various series of the Jharia coalfield :—

Raniganj series :—Huntodih (top) seam (pressure on coal : 5,600 lbs. per sq. inch; 2.07 per cent.; Bhatdih seam 1.70 per cent) Murlidih seam 2.20 per cent.

Barakar series :—Nunidih XVIII seam 1.80 per cent; Bhagaband XVII seam 1.60 per cent; Bhuggutdih XIV seam 1.27 per cent; Kendwadih XII seam 0.75 per cent; Matigara V seam (pressure : 7,000 lbs. per sq. inch) 0.65 per cent.

It may be seen from the above examples that the higher we go geologically, the greater is the moisture percentage of the coal. Similar is the case with the volatile components. Sir Cyril S. Fox has calculated the pressure of the superincumbent rock beds on certain seams. They are, according to him, 450 tons per sq. ft. or 7,000 lbs. per sq. inch on Matigara seam and 5,600 lbs. per sq. inch on the Huntodih seam. The difference is 1,400 lbs. and the moisture content changes from 0.65 per cent. on the Lower Barakar Matigara seam to 2.07 per cent. on Huntodih

seam of uppermost Raniganj beds. High moisture coals rarely coke; but it is not always the case as some of the Damodar series coals, e.g., coals of Lishu and Ramthi rivers of the Darjeeling area strongly cake⁴. Their moisture contents are 4 to 16 per cent.⁵ The effect of pressure on the volatile percentages of coal and moisture content has been the subject matter of interesting study by many famous authorities like Geikie, Hilt, etc. Hilt developed a law which runs in his name (Hilt's Law) to determine the relation between the volatile component of coal and the superincumbent pressure. His observations were made in Westphalia, Germany. He found that the deeper the seam the smaller is the percentage of volatile matter contained in the seam.

Indian coal usually consists of alternate dull and bright layers. This is not so much due to the stratified origin of coal as to the different materials which have taken part in the formation of the coal. Usually the dull part of the coal consists of *Fusain* and *Durain* and the bright part of *Clarain* and *Vitrain*. *Fusain* is soft and is like charcoal in appearance and touch, while *Durain* is hard. *Clarain* breaks into cubes.

Calorific Value

Heating value is the most important of all the properties of coal. The heating power of a coal is expressed either by its calorific value or by British Thermal Units. The British thermal unit (B.T.U.) is the amount of heat required to raise one lb. of water through 1° F., the temperature of the water being 60° F. to commence with.

The scientific unit is, however, the calorie. Calorie is the amount of heat required to raise one gram of water from 0°C. to 1°C. Calorific value of coal relates to its B. T.U. approximately 1: 1.8.

14.9 lbs. of water, theoretically speaking, will be evaporated by one lb. of carbon. An up-to-date steam engine will produce 1 h.p. by the combustion of 2 lbs. of coal.

Dry wood has the composition : 26 per cent. F.C., 72 per cent. C.C. and 2 per cent. ash; its calorific value=7,000 B.T.U. Carbonised at a temperature of 625° F., one cord of wood (=4,000 lbs.) would produce 40 gallons of turpentine, 16 galls. light oil, 128 galls. heavy oil and 950 lbs. charcoal. Carbonized wood produces red charcoal, "Rothkohle" or "Charbon rouge."

Charcoal has a calorific value of 13,500 B.T.U. and Bagasse—the tough fibre of sugar cane left behind after juice has been extracted—has a calorific value of 8,300 B.T.U. when dry. *Saw dust, straw, rice husks*, etc. can all be used as fuel. To obtain best results they require to be burnt in water-tube boilers with large combustion chambers.

A very close relation exists between the chemical composition of coal and its heating value. In general, the higher the fixed carbon content of a coal the greater is its calorific value. But this does not hold good universally. This is due to the fact that coals showing the same chemical composition sometimes possess quite different chemical construction and for that reason they might quite possibly show different properties. In general, the ash and moisture contents of coal bring down the heating power of coal. The higher the ash content of a coal the more easily does it melt (forms slag), and, therefore, a large quantity of heat is lost in the formation of the slag.

Moisture also induces the loss of heat. It uses up the heat of coal for its volatilization. At the time of burning, approximately about 6 calories of heat are lost for each percentage of moisture present in a kilogram of coal. The calorific value of peat is usually about half or one-third of good steam coal.

Calculation of the Price of a Coal from Calorific Value

As the value of coal is almost entirely dependent on its heating power, that is, its calorific value, the following method is in use in certain countries (in Germany) to determine the prices of various coals (Stutzer, O., *Kohle*, Berlin, 1923):—For this purpose the price of 100,000 calories forms the basis of calculation. The price of this quantity of heat is called "Heating price." If a coal of calorific value 7,160 calories is valued at 18.75 marks per ton, then $7,160 \times 1,000$ (calculated per kg.) calories costs 18.75 mk, or 100,000 calories cost 0.62 mk. The calculation is:—

$$\frac{18.75}{7,160 \times 1,000} \times 100,000 = .262 \text{ mk.}$$

100,000 calories is called a "Therm". Or, roughly the price of a Therm = $\frac{\text{Price per ton}}{\text{Calorific value}} \times 100$ (calculated in marks).

Taking an Indian example.—If an Indian coal of calorific value 6,000 calories is

priced at Rs. 12 per ton, then another coal of calorific value 5,500 calories should be priced as follows :—

The heating price (price of a Therm)
 $= \text{Rs. } \frac{12}{6,000} \times 100 = \text{Rs. } \frac{12}{60} = \text{As. } 3 \text{ ps. } 2.$

Therefore, the cost per ton of a coal of calorific value 5,500 calories should be
 $\frac{5,500 \times 1,000}{100,000} \times 3 \text{ as. } 2 \text{ ps.} = \text{Rs. } 11/-.$

Distillation of Coal : Coke

When coal is subjected to destructive distillation, various volatile constituents contained in coal volatilize out. At the same time the coal may melt and swell, i.e., it may cake, or, it may remain unchanged in its original shape and size. Whether a certain coal will melt or not on heating is dependent on the presence of certain hydrocarbons in the coal. About the precise nature of such hydrocarbons full information is not yet available. The percentage composition of coal as well as the presence of disponible hydrogen in coal have little to do with the caking property of coal. It is a common experience that coals possessing the same proximate analysis results are sometimes coking and sometimes non-coking. The disponible hydrogen of coal is responsible for the production of various hydrocarbons at the time of distillation of coal. The disponible hydrogen volatilizes eight times as much carbon as the same quantity of oxygen present in coal.

Coals which do not easily melt on heating give very viscous melts. Gases developed in such viscous melts blow out the melt a good deal. Hence such coals form highly swelling cokes. On the other hand, gases can evolve out readily from coals that easily melt. Therefore, the cokes of such coals do not show much swelling. The properties of coking and binding power of coals are determined by mixing quartz powder or powdered anthracite with coal before heating operation is started. During its destructive distillation the coal undergoes a very intensive decomposition. At first it gives out various gases, then tar and then coke.

Following are the results of distillation of a few Indian coals upto the temperature of 540° C. carried out by the author jointly with Mr. S. S. Ghosh :—

I. List of Coals Distilled

- (1) New Bansdeopur Colliery No. 12 seam, incline No. 15.
- (2) New Bansdeopur Colliery No. 11 seam, incline No. 14.
- (3) Sendra Bansjora Colliery No. 10 coal seam.
- (4) Sendra Bansjora Colliery No. 10 coal seam.

II. Results of Distillation Tests

- (1) Amount of coal distilled.. 7 lbs.
 Temperature of the furnace .. 525° C.
 Products :—

Coke (highly swelling hard coke), 6 lbs. 1 oz. .. at 17.32 cwt. per ton
 Tar oil (moist), 141.5 c.c. .. at 10.06 gals. "
 Amm. Sulphate .. at 6.62 lbs. "
 Gas, 12 c.ft. .. at 3,840 c. ft. "

Analysis of Gas

	%
CO ₂	2.41
O ₂	1.12
Unsaturated ..	3.5
CO	11.23
CH ₄	47.65
H ₂	27.90
N ₂	6.19

Average calorific value of the gas, 750 B.T.U.

- (2) Amount of coal distilled. 8 lbs.
 Temperature of the furnace 520° C.
 Products :—

Coke (moderately swelling coke), 7 lbs. 0.5 oz. .. at 18.28 cwt. per ton
 Tar oil (moist), 140 c.c. at 8.7 gals. "
 Amm. sulphate .. at 7.02 lbs. "
 Gas, 15 c.ft. .. at 4,230 c. ft. "

Analysis of Gas

	%
CO ₂	2.93
O ₂	0.85
Unsaturated ..	3.17
CO	12.56
CH ₄	46.95
H ₂	28.32
N ₂	5.22

Average calorific value of the gas 750 B.T.U.

- (3) Amount of coal distilled.. 10 lbs.
 Temperature of the furnace 550° to 575° C.
 Products :—

Coke, 8 lbs. 8.5 ozs. .. at 17 cwt. per ton.
 Tar oil, 150 c.c. .. at 7.5 gals. "
 Amm. sulphate .. 14 lbs. "
 Gas 4,600 c.ft. "
 Calorific value of gas.. 770 B.T.U. (I)
 744.7 B.T.U. (II)
 722.8 B.T.U. (III)

Analysis of Gas

	%
CO ₂	1.83
O ₂	0.81
Unsaturated ..	2.97
CO	7.15
CH ₄	42.0
H ₂	36.98
N ₂	7.26

(4) Amount of coal distilled .	10 lbs.
Temperature of the furnace	550° to 575° C.
Products :—	
Coke, 8 lbs. 8 ozs. ..	at 17 cwt. per ton.
Tar oil, 150 c.c. ..	at 7.5 gals. „
Amm. sulphate ..	12.5 lbs. „
Gas	4,600 c.ft. „
Calorific value of gas..	747.3 B.T.U. (I)
	725.1 B.T.U. (II)
	730.3 B.T.U. (III)

Analysis of Gas

	%
CO	4.72
O	0.63
Unsaturated ..	3.62
CO	7.08
CH ₄	46.81
H ₂	32.22
N ₂	4.92

Average for Nos. 3 and 4 Tar Oil fractions :—

Up to 90° C. .. 0.112 litre } Motor spirit, per ton
 90° to 130° C. .. 2.352 „ } of coal.

130° to 150° C. .. 2.85 litres } Light oil, kerosene,
 150° to 210° C. .. 1.8 „ } per ton of coal.
 210° to 350° C. .. 8.2 „ } Fuel oil per ton of coal.

Phenols .. 2.25 litres (Carbolic acid and creosote oil) per ton of coal.

Residual pitch .. 19.7 lbs. per ton of coal.

The coke that is left behind after the above low temperature distillation is called *soft coke* or *domestic fuel*. When soft coke is heated above 500° C. it gives out CH₄, NH₃ and H₂.

Usually for Indian coals the tar production per ton of coal distilled is approximately :—

Per cent. of volatile components minus 11 gallons per ton.

Approximately 17 c.ft. of coal gas will run a 1 h.p. gas engine for one hour. Therefore a tube of capacity 2 c.ft. containing coal gas at 150 atmospheres pressure will run a 10 h.p. motor car for about two hours or about 50 miles.

Spontaneous Combustion

Spontaneous combustion is the combustion of coal caused by oxidation of the mineral and absorption of oxygen. It is an exothermic reaction and the rate of oxidation and heat production usually increase as the temperature rises until a point is reached where the rate of oxygen absorption becomes fairly constant. All coals do not absorb oxygen at the same rate and, therefore, all coals are not subject to spontaneous heating to the same degree. Anthracite coals which have very small

volatile content have also very small capacity for oxygen, and do not, therefore, catch fire spontaneously. Coals having high volatile and high moisture contents have sufficiently large rate of oxidation to give rise to fires without the intervention of any other substance. Between these two limits are coals which fire only under favourable conditions. Oxidation is also initiated or aggravated by presence of finely distributed pyrites which oxidize more rapidly and with greater evolution of heat. Access of air to coal is necessary for oxidation to take place but where good ventilation exists, the rise of temperature is prevented. Heating is more general if the coal is broken or exposed over a large surface. Coals with high moisture and low ash content are more liable to spontaneous combustion than those with low moisture and high ash content. The bright parts of the coal known as vitrain and clarain show greater liability to oxidize and ignite than does the dull part known as durain, while fusain, the charcoal-like part of the coal is most readily ignited. In India the seams of good quality coal are as a general rule more friable than those of poor quality. The friability of a seam varies from place to place even within the same mine. Tectonic disturbances change the nature of the coal for a considerable distance from the point of disturbance. In the Jharia coalfield the upper seams of the Barakar series vary in quality and thickness from east to west. For instance, Nos. XIV and XV seams are of superior quality in the east and gradually deteriorate towards the west while the quality of Nos. XIII and XII seams is better at the centre of the field than at the eastern and western extremities.

Coal seams most liable to spontaneous combustion are those with high moisture and high volatile content. Other factors being the same, the thicker the seam and better the quality, the more liable is the coal to spontaneous combustion than that of the thinner and poorer quality seam. The seams of the Raniganj series are more liable to spontaneous combustion than those of the Barakar series. In the Raniganj coalfield, the Kajora, Jambad, Toposi and Samla seams in the eastern section of the field are, due to their higher moisture content, more liable to fire than those seams in the western parts of the coalfield, viz., Dishergarh, Poniat and Niga seams. In

the Jharia coalfield, the seams of the Barakar series, especially Nos. XIII and XIV, are most liable to spontaneous combustion; fires have also occurred in Nos. X, XI and XII seams, especially where the last two have combined to form a very thick seam. The thick seams of Bokaro and Karanpura fields are very liable to spontaneous combustion but the Giridih seams are fairly free from it. Thus, it seems that the coal seams vary in their propensities for spontaneous combustion and experience suggests that no seam may be considered absolutely safe. According to the opinion of the Coal Conservation Committee, 1937, in the seams of the Barakar series, Jharia coalfield, which occur below No. X seam and whose moisture and volatile contents are very low and ash content high, the danger of spontaneous combustion is extremely remote. On account of the high moisture and volatile content of the Raniganj series, the danger of spontaneous combustion is much greater there.

Pure slack unmixed with particles of shale band, produced from a seam of good quality coal in the Jharia coalfield contains a lower ash and a higher volatile content than the lump coal from the same seam. This is due to the higher friability of vitrain and the presence of greater proportion of

vitrain in the small coal and dust than in the lump coal in the seam. Slack, therefore, is liable to spontaneous combustion readily. Accumulation of slack coal should, therefore, be prevented in mines of good quality coals (*Coal Committee Report, 1937*).

Physical Properties

Points that should be taken into consideration when dealing with the physical properties of coal are:—colour, lustre, cleavage and fracture, hardness, friability, density, conductivity, specific heat (0.2 to 0.4), porosity, microscopic nature of coal and also colour of the ash.

4. Cleavage :

The cleavage of coal is of very great practical importance. On that depends a good deal of the productivity of the coal. The better the cleavage (shina) the more coal the coal-cutter can cut. The crystalline appearance and cleavage characteristic of many true coals are due to pressure—as a simple experiment with mud with an hydraulic press would demonstrate. There exists a close relation between the cleavage of the rock and that of the coal occurring in the rock. An interesting work in this line has been published by Prof. Briggs. No work on the relation between the cleavage of coal and that of the associated rock has yet been undertaken in India.

1. Colour :

Yellow brown to Dark brown..	Palana lignite, Bikaner State. Lashio Coal, N. Shan State.
Dull brown	Makerwal coal.
Bright jet black	Jurassic Kalabagh coal; Namma coal of Burma (Cretaceous).
Dull jet black	Gondwana coals.
Velvet black	Kalakot coal, Kashmir.
Iron black	Damodar series coal; Wakching coal, Naga hills.
Bluish black	Miocene coal of Assam.

2. Lustre :

Vitreous	Gondwana coals, especially their vitrain and clarain.
Dull	Karharbari coal and Salanpur seam coal as well as the duller bands of the Raniganj and Barakar series coals.
Waxy	Makerwal coal.
Pitch-like	Kalabagh coal.
Metallic	Upper Chindwin coal, Burma.
Resinous	Coal possessing resinous lustre is found in Makerwal, Borjan, etc.

3. Streak :

Brown	Tertiary coal, excluding those that are anthracitic (e.g., Kashmir coal).
Greyish black	Gondwana coal.
Black	Fusain of Gondwana coal.

Classification and Grades

There are almost endless varieties of coal, and it is extremely difficult to classify coal. This diversity is due to the fact that there was no one original mother substance, no one original mode of accumulation and no one mode of conversion in case of coal. Coal has been classified according to chemical composition, heating value, or physical characteristics. The first classification, perhaps the one which is most satisfactory, is dependent upon its chemical properties, but the one generally used is that based on physical properties of coal. According to their physical properties the different varieties of coal are divided into Peat, Brown coal, Lignite, Bituminous coal, Cannel coal and Anthracite.

Broadly speaking, Indian coals belong to three main classes of coal, viz., lignitic coal, bituminous coal and anthracitic coal. The Tertiary coals of Assam, Punjab and Baluchistan are usually lignitic. The Gondwana coal of India is bituminous coal. Some of the Himalayan coals which occur at Kalakot (Kashmir) and certain sections of the coal of the Salanpur "A" seam, (Raniganj coalfield) are examples of anthracitic coal.

1. *Peat*.—This is the first stage in the change of wood to coal. It is brown, fibrous, light and friable. The so-called Palana lignite and the thick masses of coal occurring in the Katmandu valley, Nepal, are examples of peat. Peat looks like compressed hay of brown colour in which plant remains are distinct and abundant. Khulna and Barisal Districts of South Bengal contain many peat beds. Palana lignite looks exactly like peat but someone has mistakenly called it lignite. For peat formation the degeneration of vegetable matter should take place in depressions, the floors of which are impervious to water. The change of wood into peat is brought about by moist atmospheric oxidation with the help of anaerobic bacteria, yeasts, moulds and fungi in stagnant or semi-stagnant water. Peat formation goes on very slowly. In certain places of England peat has increased in vertical thickness from 3 to 5 feet since the Roman invasion. In Germany the yield per square kilometre is about 800 tons of air-dried peat per year. The total reserve of peat for the whole world is 200 thousand million tons (air-dried). Peat is best used when briquetted; in Bavaria they manu-

facture carbonized briquettes of peat. These are semi-coke briquettes. During its manufacture large quantities of by-products are obtained. Producer gas is also manufactured from peat.

2. *Lignite*.—Lignitic coal is more or less the same as brown coal. But lignite perhaps is a coal which has retained some of the woody structure, while brown coals have not. Lignite is a French word derived from *Lithanthrax lignius* used by Wallerius (1775) for woody coal⁶. The calorific value of lignite can vary between 8,000 to 10,000 B.T.U.⁶ Lignite burns with much smoke and flame. As stated above, some of the Tertiary coals of Assam, Burma, Punjab and Baluchistan are examples of Indian lignites.

3. *Bituminous Coal*.—Bituminous coal is the name of true coal other than anthracite. It derives its name from the fact that it produces a flame similar to that of bitumen, although it contains no trace of bitumen. Bituminous coals are sub-divided into coking and non-coking coals and each one of them in turn into gas coal and steam coal. Coking coal is used for coke making as well as for making domestic fuel, the soft coke. The Gondwana coal of India is bituminous coal. Some of the Assam Tertiary coals and the Jurassic coals of Burma are also bituminous. Bituminous coals are also sub-divided into high-volatile and low-volatile coals according to the ratio of fixed carbon to volatile constituents. If the quotient of fixed carbon divided by volatile constituents is less than 2 (approx.) then the coal is a high-volatile coal. When it is more than 2, it is low-volatile. The coal of the Raniganj series is usually high-volatile coal, free from sulphur. Some of these coals, e.g., Dishergarh and Poniaty coals as well as Murulidih coal contain more than 32 per cent. volatile constituents. High-volatile coals are used in gas industry, coal-tar distillation industry, and glass works. They usually are "long flame coals." Low-volatile coals are usually "free burning coals." According to the sizes of the lumps, all coals are divided into *steam coal* (average diameter 3" and above), *rubble coal* (average diameter 1½" to 3"), and *slack coal* (dia. < 1½").

4. *Cannel Coal*.—The name "cannel" comes from the candle-like flame with which this coal burns. It is a dull hard coal showing no laminations, which is the general

characteristic of bituminous coal, and is of great value as gas coal.

5. *Anthracitic Coal*.—Anthracite is the last stage in coal formation. It is no doubt bituminous coal altered by heat and pressure. It is extremely hard, has a brilliant black lustre; it sometimes breaks into cubes and does not soil the finger when handled. It is difficult to ignite but when once alight burns with very great heat and practically no flame or smoke. Examples of anthracitic coals in India are some of the Himalayan coals as well as the coal of certain sections of the Salanpur "A" seam of the Raniganj coalfield.

The characteristics of all miniature coals—peat, brown coal and lignite—are high moisture and volatile contents and low fixed carbon.

Cannel coal has been sub-divided into splint coal, parrot coal, etc. On account of the cracking noise which some variety of the cannel coal makes when put in fire, it has been called "parrot coal" in Scotland. (For an outline of the gradual change of wood into coal, see Table II.)

A very scientific classification of coal has recently been developed by Dr. Mary Stopes. According to her, all coals consist of four substances. They are : *fusain*, *durain*, *vitrain* and *clarain*. *Fusain* is the charcoal-like non-shining mother of coal, *durain* is a dull bituminous coal (Giridih coal, Salanpur "A" seam coal) ; *vitrain* is the bright part of coal which possesses conchoidal fracture and *clarain* is the bright coal that breaks into cubes.

A rather empirical system of classification of coal was in vogue in India until recently. This classification goes by the name of

the Grading Board classification of coal. The details of the Grading Board classification are given at the foot of this page.

Geological Distribution of the Coalfields

Formerly coal was recklessly sought for in almost every geological formation and much waste of money occasioned in useless boring and sinking operations. Now, however, the coalfields have been accurately mapped by the geologists so that a good deal of scientific information can be obtained from them and from these maps the mining companies can decide upon the best sites for inclines and shafts. There yet remain, however many parts where the mining engineer will have to carry out his own geological investigations.

From the geological standpoint the coalfields of India can be grouped under four heads, namely, (1) Gondwana coalfields; (2) Jurassic coalfields; (3) Cretaceous coalfields ; and (4) Tertiary coalfields (Table I). Of these, the Gondwana coalfields are the most important. In 1938, they produced 98.17 per cent. of the total coal mined in India. Of these the Jharia coalfield was responsible for about 39 per cent. (about 11 million tons) and Raniganj coalfield about 31 per cent. (about 8½ million tons); next in importance come the Bokaro coalfield 7 per cent. (about 2 million tons), Pench Valley about 5 per cent., Korea about 4 per cent., and Singareni, Karanpura and Giridih more than 2 per cent. each. Of the remaining 1.83 per cent. the Tertiary coalfields of Assam produced about 1.11 per cent. (about 278,000 tons) and the Punjab 0.65 per cent., i.e., about 184,000 tons (see Table IV).

		Low-volatile	High-volatile
Selected Grade	..	Up to 13 per cent. ash and over 7,000 calories or 12,600 B.T.U.'s.	Up to 11 per cent. ash ; over 6,800 calories or 12,240 B.T.U.'s and under 6 per cent. moisture.
Grade No. 1	.. ..	Up to 15 per cent. ash and over 6,500 calories or 11,700 B.T.U.'s.	Up to 13 per cent. ash ; over 6,300 calories or 11,340 B.T.U.'s and under 9 per cent. moisture.
Grade No. 2	.. ..	Up to 18 per cent. ash and over 6,000 calories or 10,800 B.T.U.'s.	Up to 16 per cent. ash ; over 6,000 calories ; or 10,800 B.T.U.'s and under 10 per cent. moisture.
Grade No. 3	..	All coals inferior to above.	

The distribution of the Gondwana coalfields is suggestive of four great basins of deposition : (1) The Wardha-Godavari valley ; (2) the Satpura region ; (3) the Basin of the Mahanadi, and (4) the fourth and the most important one stretching eastwards from Rewa *via* Korea and Sirguja States to Damodar and Barakar Valleys and thence to Rajmahal hills and possibly to Darjeeling Himalayas. Mallet thinks that there are still a few coalfields hidden under the Gangetic alluvium between Rajmahal hills and Darjeeling area ; it is also believed that many Gondwana coalfields are lying buried under the Deccan Trap lava flows in Western India. Accurate geological investigation carried out by the author of this note in Mewar, Rajputana, on behalf of the *Geological Survey of India*, has led him to believe that the extensive zinc-lead-silver deposits of Jawar occur most probably in Gondwana rocks, overfolded over older (Aravalli) rocks. Inside the four basins mentioned above, there are in India about 70 productive and unproductive coalfields with a total area of about 30,000 sq. miles.

On provincial basis, about 30 of these coal-fields are in the Central Provinces; 22 in Bihar and Orissa and the rest in Bengal, Madras and Hyderabad State. The coalfields of Bihar are responsible for the production of more than 50 per cent. of the total coal of India. Jharia coalfield is the most important coalfield of India. The proportion of coal to rocks in this field is 1 : 14. The total thickness of the Gondwana rocks in the Jharia coalfield is about 6,000 ft. of which the rocky portion is 5,600 ft. and coal seams 400 ft. These strata are distributed as follows :—

Raniganj series :—coal 90' : Rock 1800' = 1 : 20.

Barren measures :—Rock 1500'.

Barakar series :—coal 300' : Rock 1700' = 1 : 6 (approx.)

Talchir series :—Rock 600'.

There is no other coal-bearing area in India excepting the Barakars of the Jharia

TABLE I. *Geological succession of strata in which potentially workable seams of coal are found in India and Burma (after Fox).*

Geological Epoch.	Lapse of time (in million years) since epoch began.	Coalfields in India and Burma	
10. Pleistocene.	6	Lashio, Nam-ma, etc., in Northern Shan States, Burma.	Tertiary Coalfields.
9. Pliocene.	15	Karewa of Kashmir.	
8. Miocene (?)	30	Namchik, Makum, Jaipur, Nazira and the Naga hills coalfields in Assam.	
7. Upper Eocene	45	Cherapunji, Mao-long, etc. of Khasi and Jaintia hills, Assam, Kalewa and Yaw River coalfields in Northern Burma.	
6. Lower Eocene	60	Palana in Rajputana, Khost and Mach in Baluchistan, Kalakot in Kashmir and Dandot and Makerwal of the Punjab.	
5. Cretaceous.	135	Daranggiri, Rongrengiri, etc., in the Garo hills and some fields of the Khasi and Jaintia hills in Assam.	Cretaceous Coalfields.
4. Upper Jurassic.	192	Coal seams of Cutch, Lameta Ghat coal in Narmada Valley.	
3. Lower Jurassic.		Loi-an, Panlaung River fields in Burma. Kalabagh coal in the Punjab.	Jurassic Coalfields.
2. Upper Permian.	240	Raniganj and Jharia coalfield and some seams of the Bokaro Coalfield in the Damodar Valley, Darjeeling Himalayas coalfields.	
1. Lower Permian	270	All Lower Gondwana coalfields in Peninsular India including Damodar Valley, Mahanadi-Brahmani Valley, Pranrita-Godavari Valley, Pench Valley, Wardha Valley, Son Valley coalfields, etc. Graphitic shale beds of Mewar (Rajputana) (?)	Gondwana Coalfields.

field where the proportion of rock to coal is 1 : 6. Considering that approximately about 6 ft. of wood makes 1 ft. of coal, it seems that during the Barakar period the proportions of deposition of wood and detrital matter were equal in quantity.

The Gondwana system includes a time interval which stretches from the close of the middle Carboniferous to the beginning of the Cretaceous period. The age is determined on floral basis. Its equivalent formation in other countries are the Karoo formation of South Africa, Santa Catharina formation of S. America and similar Carbonaceous formation in Australia. So once during the geological epochs these areas were together. As stated above, in India the Gondwana coalfields occur in four distinct basins. The Gondwanas are divided into Lower, Middle and Upper divisions. The Lower Gondwana is the most important coal-bearing formation. Rocks found in these coal-bearing areas are both sedimentary and igneous.

The lowest beds of the Lower Gondwana are known as the *Talchir series*, from their first recognition in the Talchir State of Orissa. The component rocks are green laminated shales, sometimes called olive shales, and fine grained, green sandstones. The sandstones contain undecomposed felspar grains, a fact which suggests the prevalence of land ice in Talchir period.

Glacial conditions are, however, more clearly indicated by Talchir boulder-bed also of very wide prevalence in all the Gondwanas areas.

The *Barakar stage* rests conformably upon the Talchir rocks and consists of coarse, soft, usually light coloured, massive sandstones and shales, with coal seams. Ripple marks, rain drops and false-bedding occurring in Barakar sandstones, as well as its plant fossils prove that the Barakar series of rocks is a river deposit. The Barakars contain a large quantity of coal in thick coal seams.

The *Iron-stone Shales* are a great thickness of micaceous and carbonaceous shales with concretions of impure iron carbonate and oxide. Rocks of the Iron-stone shale series do not contain coal.

The Iron-stone Shale series is succeeded by the *Raniganj stage* of the Damuda series, named from the important mining town of Bengal. The Raniganj stage is composed of massive, false-bedded, coarse and fine sandstones and red, brown and black shales, with numerous siderite bands and inter-bedded coal seams. The sandstones are felspathic, but the feldspar in it is all decomposed, i.e., kaolinised. In this case also false bedding is common which proves it of river origin.

The most important Tertiary coal measures in India are those of Upper Assam (1) bordering the Shillong, Patkai and Naga hills and (2) those of the Namchik, (3) Makum and (4) Nazira coalfields—where petroleum is found in association with the coal.

Some of the coal seams in the Makum field are upwards of 20 feet in thickness, as at Tippong Pani and up to 60 feet thick as at Namdang. The association of petroleum with coal in Assam is of considerable interest. There appears to be some sort of a genetic relationship between the coal and the oil in Assam. It suggests that both have been formed by accumulated vegetable matter of the Miocene forests. Coal-forming conditions in marine sediments appear to have been present at two geological horizons in the Assam region.

The coal of the Cherrapunji locality overlies the so-called Sylhet (Eocene) Nummulitic limestone. There seems to exist a certain interesting relation between coal-oil-limestone in *this* area. At Mawsynram, coal is developed where the Nummulitic limestone is thin. This is the condition of affairs at

Cherrapunji and records a change from marine to estuarine conditions. In the south where the limestone is thick, coal is never found but oil is frequently met with. Further west, in the Garo hills, in the Daranggiri and adjacent fields, the coal seams underlie Eocene limestone and occur in Upper *Cretaceous* strata. The Upper Cretaceous coalfields strata of the Khasi hills are also associated with marine strata.

Of almost equal scientific interest as the successive petroleum coal-bearing formations of Assam, are the lower Tertiary (Laki series) coals of North-Western India which are also associated with petroleum. These consist of the peaty lignites of Palana in Rajputana, the high-volatile coals of Baluchistan, Sind and the Punjab, and the high and low-volatile coals of the two series in Jammu (Kashmir).

The presence of marine foraminifera, Assilina and Nummulites, both in and above the coal seams near Dandot, in the Punjab Salt Range, indicates clearly that the vegetable debris accumulated in the sea, and the fossil evidences obtained from the Rajputana, Baluchistan and Kashmir occurrences point to the same conclusion for all these coals.

The oldest (Jurassic) marine coal seams, of workable thickness, although of unknown economic value, are those occurring near Trombow in Cutch.

Prospecting

The rocks found in association with the Gondwana coals, namely, Talchir rocks, Barakar sandstones and Raniganj sandstones, possess very characteristic properties. Everywhere the Talchir shale, be it from the Himalayas, Bengal, Bihar, Central Provinces, or Australia, looks exactly alike, and the same can be said of the Barakar sandstone. Even the Karoo sandstones of South Africa, which are the lower coal-bearing sandstones of the South African Gondwana coalfields, look exactly like our Barakar sandstones. Thus, the rocks of the Gondwana coalfields are very alike and very characteristic. In the Punjab the coal occurs under Nummulitic limestone, in Assam with Tipam sandstone. The Nummulitic limestone of the Salt Range has also as characteristic an appearance of its own as the Barakar or the Talchir sandstones of the Gondwanas. Thus it is from the rocks that the first clues to the coal are obtained. A preliminary

examination of the surface rocks is first of all made when searching for coal in an unknown district. Knowing from that search the nature of the rocks and the geological formation to which these rocks belong, some idea may be formed as to whether coal is likely to be present or not. If one comes across these rocks of the coal measures, e.g., Barakar, or, Raniganj sandstones, or Nummulitic limestone, or Tipam sandstone, then one knows that coal may be found somewhere in the vicinity. If the coal is really present there, it is bound to reveal itself somewhere in the Barakar sandstone or the Raniganj sandstone of the Gondwanas or under the Nummulitic limestone or Tipam sandstone of the Tertiary areas. Thus the Raniganj or the Barakar sandstone, or, the Nummulitic limestone or the Tipam sandstone tells us about the possible presence of a coal in a field, and they determine the possible presence of a coalfield. Bore holes have to be put down to definitely locate the seams. But boring should not be done in a haphazard manner. Before boring is undertaken one has to be sure about the presence and possible position of a coal seam in the area from natural exposures. These natural exposures of the coal seams are to be found in localities where there is a continual removal of the obscuring material of coal, such as in the beds and banks of rapid-flowing streams, at waterfalls, and landslide scarps. These localities should be first visited. In following up the stream and ravine courses and other possible places for obtaining clues of coal seams, e.g., sand-banks, stream scars, upturned tree stumps, wells, pits, burrowings, lines of springs, and patches of water-loving vegetation, all of which may give us some clue for coal, one should closely scrutinise whether the alluvium contains coal fragments or fine particles of coal, commonly called "coal wash," "coal bloom," or "slum." In many localities, even in a paddy field, the presence of coal may be detected by the occurrence of grey or black soil; or sometimes the presence of a coal seam is known by the occurrence of a fused or baked, brick-red or white, clinker, shale, or sandstone, which has resulted from the spontaneous combustion of the coal seam, or of coal seams set afire by an ancient forest fire along the outcrop. Should the coal seam be not exposed, its position can

in many cases be determined to help the subsequent boring operation by sinking a line of prospect pits, or trenches at short intervals, across the measures. In many cases the position of a concealed coal seam can be readily recognized by the trained eyes of a prospector by the configuration of the topography. For instance, the position of the coal seams on the hill-slopes is generally indicated by a bench, terrace, as in the Kuresia field, reported by Mr. M. L. Shom, or in the flat Gondwana areas their outcrops can be traced from shallow troughs caused by the more rapid erosion on the outcrops of the soft decomposed coal than of the adjacent sediments. Examples of such shallows and heights are available in the Godhur, Gondhudi and Kusunda areas of the Jharia coalfield, Bihar.

A coal seam having been discovered, sufficient of the obscuring material and weathered coal should be removed to determine its thickness, character, dip and strike, as well as the character of the immediate overlying and underlying beds. Where the overburden so obscures the rock as to make pit-prospecting too expensive, diamond drilling may be resorted to, to determine the position, attitude, thickness, number and character of the coal seams. In some fields the coal seams are so badly broken by faults that a great many drill holes have to be put down before satisfactory data to plan the future working of the property are obtained.

Correlation of Coal Seams

The usual methods of correlation of coal seams can be summarized as follows:—

(1) Physical method. The coal seams usually maintain the same thickness through considerable distances; seams of same thicknesses with same association, e.g., the stone band in the middle of the 10th seam, Jharia, are considered to be one and the same. Seams are also correlated by their characteristic lustre (dull or bright), colour and streak.

(2) Geological method. Seams occupying the same geological horizon as determined by mapping or by simple counting from the bottom or top of a coal-bearing formation, as is the case in the Jharia coalfield, or from a fixed horizon, or a key-horizon or from a characteristic seam of the field, are considered to be alike. The behaviour of a seam usually even after dislocation remains the same.

(3) Chemical method. Two coal seams may be correlated to each other if their proximate analyses show the same result and if both of them are of coking or non-coking nature.

The above three methods have upto now been generally used for the correlation of the coal seams of India and from the available maps of the coalfields it has been usually considered that the correlation work of the coal seams in India is complete. But still a good deal remains to be done towards the accurate correlation of seams. The other methods of correlation are:

(4) Petrological methods.

The following two petrological methods have been successfully employed for the purpose of correlating sedimentary rocks in general and as such are useful to correlate coal seams accurately. Out of these, the second method has been tried with success in the Geology Laboratory of the Indian School of Mines to correlate the rocks of the Coal Measures and the various coal seams. The two methods are:

(i) Crook's Elutriation method:

According to Stokes,

$$V = \frac{2}{9} \frac{gr^2(d-d_0)}{u}$$

where V = Velocity of precipitation.

g = acceleration of gravity measured in dynes

r = radius of the particle

d = density of the particle

d_0 = density of the liquid

u = viscosity of the liquid.

From the formula it is evident that the greater the dimension of the particle, the greater the influence of the force of gravity on it. Specific gravity is not the deciding factor but size. So from the formula used in the construction of the Crook's Apparatus, the fine and coarse elements of a sandstone can be separated and their percentage in the rock accurately determined to ascertain the nature of the rock associated with a coal seam. (For details, see Niggli P., *Lehrbuch der Mineralogie*, Berlin, 1920, p. 436, and Holmes A., *Petrographic Methods and Calculations*, London, 1930, p. 206.).

(ii) Heavy residue method. On careful investigation of the heavy mineral crops, i.e., of minerals contained in the sedimentary rock, whose sp. gr. is more than

that of bromoform (sp. gr. 2.86), a definite characteristic of the rock could be established. The following heavy minerals were found in the Coal-Measures sandstones of the Jharia and Raniganj coalfields: Biotite, Chloritoid, Epidote, Peidmontite, Garnet, Hæmatite, Ilmenite, Kyanite, Magnetite, Monazite, Muscovite, Rutile, Zircon, Staurolite, Topaz, Tourmaline.

Out of these heavy minerals the prevalence of garnet, tourmaline and zircon in the coalfield sandstones are very interesting. It has been seen from the figures for the percentages of zircon and tourmaline in both Raniganj and Jharia coalfields, that one of them varies at the expense of the other.

Again, the percentages of the grains of heavy residues in Barakar sandstones and Raniganj sandstones are very characteristic.

<i>Barakar Sandstone</i>	
Magnetite, ilmenite and leucoxene ..	40 to 70 per cent.
Tourmaline ..	2 to 50 per cent.
Zircon ..	2 to 50 per cent., usually 15 per cent.
Rutile ..	2 to 10 per cent.
Garnet ..	Generally absent, when present usually about 2 per cent.; never 50 per cent.
<i>Raniganj Sandstone</i>	
Magnetite, ilmenite and leucoxene ..	Usually 2 to 10 per cent. seldom above 15 per cent.
Tourmaline ..	Usually 1 to 10 per cent., rarely 15 per cent.
Zircon ..	0 to 10 per cent., usually 1 per cent.
Rutile ..	0 to 5 per cent.
Garnet ..	70 to 90 per cent., seldom below 50 per cent.

Garnet determines a Raniganj sandstone even though it might look exactly like Barakar sandstone. Thus the Raniganj and Barakar sandstones which might sometimes look alike can be easily distinguished by their heavy mineral crops.

In the same way, it is possible to distinguish between the roof and floor rocks associated with one seam from those of the other seams and thus much help may be obtained for the correlation of seams.

(5) Palæontological method. According to the palæontological methods of correlation, coal seams are correlated by means of their plant fossil evidence; but it is not easy to distinguish one *Glossopteris* or

Gangamopteris from another Glossopteris or Gangamopteris. This requires expert study.

(6) Microscopic method. Considerable assistance for the correlation of seams can also be obtained from a microscopic study of coal under the reflection microscope. A comparatively large quantity of pollen grains and spores are found in coal. During the incoaling process (see Table II) they were more resistant to weathering than the woody matter. Hence under the reflection microscope we find that the coal consists of a much greater proportion of spores and pollen grains than what can be ordinarily expected. By recording individual spore types and percentages of spores of similar magnitude we find that their contents are different in different seams. It has been found by this kind of percentage calculation, i.e., by some sort of spore census, that it is remarkably the same in the same section of the seam. Among other characteristics of coal that can be noted under the reflection microscope is that spore material of bituminous coal is much less reflective than that of anthracitic coal. Anthracite and anthracitic coals are not isotropic when examined under polarized reflected light.

The science of microscopic examination of coal is still at its infancy. But microscopic study, in course of time, is expected to afford much useful help for the correlation of coal seams.

Origin

It has now been definitely settled that coal is the changed product of wood. This we have known by the presence of woody matter such as tree trunks and tree stumps in the coal seams themselves as in the Victoria Park near Glasgow and Quarry Marie II near Great Raeschen, Germany, which can be actually seen. Further a thin slice of a sample of coal examined under a powerful microscope will often reveal distinct traces of woody tissue and bark (Wilson, T. H., *Coal*, p. 1). Two kinds of woody structures, one consisting of tissues and the other consisting of thallas of the fungi were long discovered. The thallie are known as Pila and Reinschia. The latter is a sack like thallus while the former consists of oval or circular thallie. In addition to them coal always contains a considerable amount of pollen grains

and spores. The spores and the sacks that contain the spores, the seeds of the flowerless plants, are more distinctly seen under the reflection microscope.

The change of wood into coal did not take place on the land surface. It took place under water. Had the change taken place on the surface, exposed to the oxidizing influence of air, nothing but ash would be left behind. According to Potonie, during the coaling process, wood is first changed into *Sappropel*, a gelatinous mass, perhaps under the biochemic influence of some bacteria. The devolatilization of the mother substances also started under biochemical action and the sappropel was ultimately rendered compact and dense and changed into coal by metamorphism (see Table II).

Usually it is seen that the accumulation of original substance for coal took place either in lakes or in gulfs, or at the mouths of the rivers or along river beds. Hence the coal and coalfield rocks are either lacustrine, estuarine or fluvatile deposits. The Gondwana coal deposits are fluvatile or lacustrine deposits while most of the Tertiary coalfields of Assam and the Punjab were deposited under estuarine conditions.

TABLE II. Outline of Coal Formation*

ORIGIN OF COAL		
A. The Material		
(Lignocelluloses, Vegetable Proteins, Resins, Fats and Waxes.)		
B. First Stage of Change.		
(a)	(b)	(c)
Fermentation, formation of Peat Bog with Evolution of $\text{CH}_4, \text{CO}_2, \text{H}_2\text{O}$	Maceration by water, and possibly also segregation, giving (a) Colloidal solutions (gels), (b) Insoluble matter.	Transportation by water and Redeposition elsewhere (sometimes).
C. The Second Stage.		
(a)	(b)	
Blanketing under newer strata and consolidation and de-watering of the mass by pressure.	Earth movements producing laminated structure.	
D. The Third Stage, or Bituminization Stage.		
Under influences of pressure and (subordinately) slowly rising temperature:—		
(a) Progressive de-watering;		
(b) Loss of CO_2 and H_2O and CH_4 by internal condensation;		
(c) Amalgamation of acidic and basic humic bodies;		
(d) Development of coking constituents from phenolic bodies.		
E. The Fourth Stage or Anthracitization Stage.		
Anthracitization of the bituminized material under influence of pressure and temperature.		
* Bone, <i>Coal—its Constitution and uses</i> , 1936, p. 35.		

(To be continued)

RADIO INDUSTRY

WITH SPECIAL REFERENCE TO BROADCAST RECEIVERS AND VACUUM TUBES

By V. V. L. RAO

(Provincial Broadcasting Department, Government of Madras)

Introduction

DURING the two decades following World War I, the radio industry established itself as one of the leading electrical industries in several countries of the world. In the post-war plans of every country, notably in the U.S.A. and U.K., radio industry looms large. In the U.S.A. the post-war electronic production figures are estimated at a billion dollars (\$1,000,000,000) annually, or more than three times the pre-war figure. It is even suggested that the huge post-war contracts may push the output in the U.S.A. to four billion dollars to meet the anticipated heavy civilian demands.

Plans for the establishment of large-scale radio-receiver component manufacturing industry as a part of the post-war plans are being considered by scientists and industrialists in India. It is useful, at this stage, to have a working knowledge of the industry as obtaining in the U.S.A. and other countries, the raw materials required and the processes involved in their manufacture. Such a survey is attempted in this article. The principal products considered are the sound broadcast receivers and vacuum tubes.

Radio industry is comparatively a new industry, started after the last Great War; it has developed into a very big industry during the last decade, representing millions of men, money and machines, notably in the U.S.A., Germany, England, the U.S.S.R. and Holland. Among these countries the radio, like the automobile and aeronautical industries, operates in the U.S.A. on a mass-production basis.

Developments in America

The period 1922-41 is of special interest in the history of the radio receiver industry in the U.S.A. Prior to 1921, the industry was restricted to sale of a small quantity of amateur and marine radio equipment running into a few hundred thousand dollars annually. Since 22nd April 1942, the American manufacturers have been prohibited from manufacturing civilian receivers in order that the industry may concentrate solely on the manufacture of defence commu-

nication equipment for the U.S.A. Army, Navy, and Air Force. The production of such equipment in 1942 was estimated at \$125 million, excluding vacuum tubes estimated at \$90 million.

During the period 1922-26, home-made receivers were displaced by factory-made receivers. The entire production of this period was of the multi-battery type (A, B and C batteries). In the next six-year period (1927-32), the receivers manufactured were of the compact, all A.C. mains-operated type. 1929 was a boom year when nearly 4.7 million receivers, valued at about \$600 million, were produced.

During the third five-year period (1932-36) considerable attention was paid to the solution of the problem of *selectivity* in the crowded ether channels of the U.S.A. The mains-operated *superhet* became popular. In 1935 about 6 million receivers, valued at over \$302 million, were produced. The average price of receivers fell; the price of primary receivers ranged between \$20 and \$50, and that of the secondary receivers between \$6 and \$25 (Rs. 18 and Rs. 75).

During the last five-year period (1937-41), several new innovations were introduced. They were: 6-volt, car-battery operated (sole power supply) set; push-button tuning of pre-selected stations; magic eye to facilitate tuning; mass manufacture of cheap table models and portable models; radio-phonograph combinations with recorders; and frequency-modulation adapters.

Radio Receivers

Up to 1940, practically the entire production of receivers in the U.S.A. consisted only of the amplitude-modulated receivers and in view of the growing popularity of frequency modulation (F.M.), whose transmissions are claimed to give "static-less reception" and "breath-taking fidelity," several receivers were designed to receive F. M. transmissions. During the past few years, separate F.M. adapters were also sold for converting the existing A. M. sets to F. M. sets.

Broadcast receivers and accessories may be classified as follows:--(a) Table models,

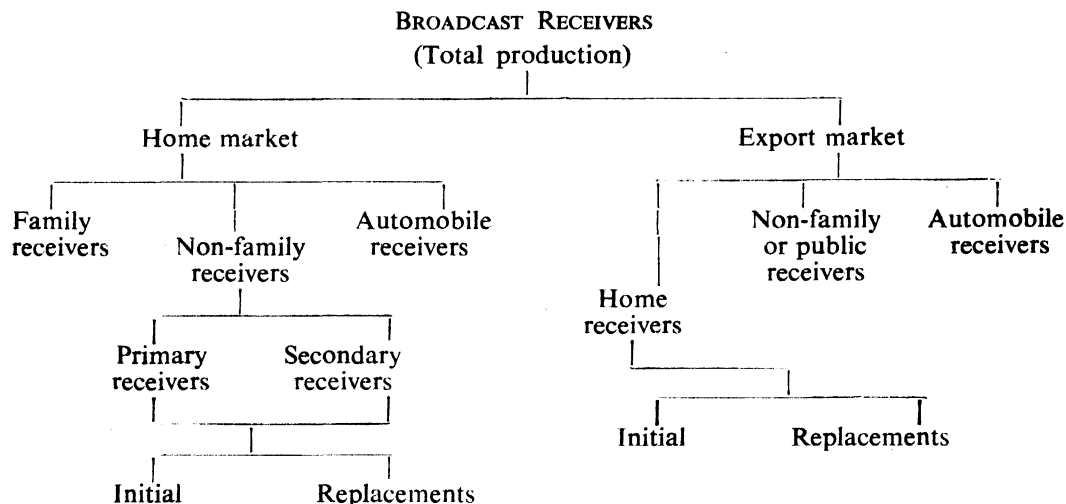
(b) Consoles, (c) Portable sets, (d) Automobile sets, (e) Farm battery sets, (f) Radio phonograph combinations, (g) Radio phonograph recorders, (h) Record players only (i) Chassis without cabinet, and (j) Frequency modulation adapters. The total number of units of the above types produced in the U.S.A. in 1941 was 13.8 million, having a retail dollar value of \$438.5 million. The total production of broadcast receivers can be analysed as below.

There was hardly any export trade in radios during the period 1922-25. Since 1926

were exported into India recently under Lease-Lend.

In the early boom days, there were 3,000 to 5,000 manufacturers in the U.S.A. The following figures (approximate) are representative of the number of manufacturers, but the bulk of the trade is concentrated in a few leading firms.

Year	No. of Manufacturers	Year	No. of Manufacturers
1925	.. 430	1934	.. 110
1929	.. 96	1935	.. 102
		1941	.. 100



Explanation: *Initial* radios are sets purchased each year by those families who have not previously owned radiosets; *Replacement* sets are purchased by those who previously owned receivers which became obsolete or given in exchange for more recent models; *Primary* receivers are intended for the whole family, installed in the living room or drawing room; *Secondary* receivers are auxiliary receivers installed in the children's bed room, dining-room, etc., as also portable sets for picnics, railway or other journeys. They are still uncommon in India though very popular in the U.S.A.; *Non-family* receivers are sets intended for community-listening in workshops, retail stores, factories, clubs, schools, etc.; *Automobile* receivers are permanently installed in automobiles.

onwards, the export trade with India, Canada, and the South American States has been on the increase. Several thousand receivers

By the end of 1941, 30.3 million families in the U.S.A. possessed about 57 million radio receivers. About 90 per cent. of the

TABLE I. Statistics of the Radio Receiver Industry in the U.S.A. for the Year 1941.

	No. of units	Retail dollar volume \$	Average list price of units \$	Approximate equivalent price in Rs. (taking 1 \$=Rs. 3) (price of units)
1. Radio receivers—				
(a) Table models	6,100,000	108,000,000	17.70	53.10
(b) Consoles	640,000	46,500,000	72.70	218.10
2. Portable sets	1,660,000	42,800,000	25.70	77.10
3. Automobile sets	3,040,000	111,000,000	36.50	109.50
4. Battery sets	790,000	20,900,000	26.40	79.20
5. Radiograms—				
(a) Combination table models	548,000	21,600,000	39.40	118.20
(b) Console models	416,000	61,800,000	148.00	444.00
(c) Radiogram recorders	53,000	7,100,000	134.00	402.00
6. Record players	186,000	4,750,000	25.50	76.50
7. Chassis without cabinets	330,000	13,700,000	41.50	124.00
8. Frequency modulation adapters	9,000	360,000	40.00	120.00
	13,772,000	438,510,000	31.80	165.06

homes were equipped with radios. The output of receivers increased from 0.1 million (valued at \$5 million) in 1922, to 13.8 million (valued at \$438.5 million) in 1941.

Table I gives statistics of the radio receiver industry in the U.S.A. for the year 1941.

The average life of an American receiver during the last decade was estimated at about seven years, which compares favourably with the life of a car. In a radio receiver there are no moving parts to wear out; when a few parts deteriorate and fail with usage, humidity and temperature, they can be replaced easily.

Radio Tubes

The thermionic tube, which, amongst other things, amplifies several times the original strength of the feeble radio energy intercepted by the receiving aerial, is the rock-bed of the great radio industry.

The distribution of radio tubes produced in the U.S.A. can be schematically represented thus:—

tubes. The total production during the years 1938 to 1940 was as follows:—

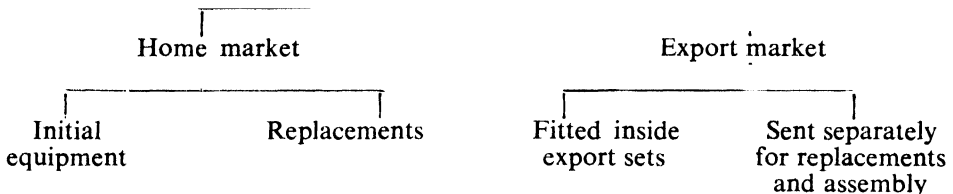
Year	Production
1938	70 millions
1939	100 "
1940	110 "

The annual output of tubes from the R.C.A. Factory at New Jersey is said to be 30 millions. On an average, an American set consists of 6 to 7 valves. Table II gives the annual production and distribution of vacuum tubes for broadcast receivers in the U.S.A.

It is interesting to record that the production of vacuum tubes has proceeded from one million in 1922 to 110 millions in 1940. The exports form but 13 per cent. of the U.S.A.'s domestic consumption.

The average life of an American tube is said to have increased from 1.65 years (1924) to 4.58 years (1938). Its life is much longer than the usually assumed figure of 1,000 hours. Investigations reveal that a family uses the radio for about 4 hours a

VACUUM TUBES (Total production)



Vacuum tubes produced are essentially of two kinds from the point of view of external envelope: (1) Glass tubes and (2) metal

day, i.e., 1,460 hours in a year. With a tube life of 4.58 years, a tube may be expected to serve for 6,500 hours!

TABLE II. *Annual Production and Distribution of Vacuum Tubes*¹.

Year	Total quantity of valves produced	Domestic: for initial equipment	Sales: for replacements	Export: total exports	Sales: tubes exported with sets	Tubes exported separately
1922	1,000,000	1,000,000				
1923	4,687,400	4,687,400				
1924	12,000,000	8,000,000	4,000,000			
1925	23,444,035	11,720,000	11,725,035			
1926	30,000,000	11,290,000	17,559,000			
1927	23,650,733	13,320,000	9,078,733	1,252,000	530,000	722,000
1928	50,200,000	21,475,000	27,492,000	1,233,000	675,000	558,000
1929	70,584,323	33,495,000	34,351,323	2,738,000	1,505,000	1,233,000
1930	40,212,891	20,178,000	1,678,891	3,246,000	1,472,000	1,774,000
1931	47,504,298	21,275,000	21,029,298	5,200,000	2,825,000	2,375,000
1932	47,047,138	12,517,000	29,319,138	5,211,000	1,453,000	3,758,000
1933	62,428,803	21,905,000	32,579,803	7,944,000	2,545,000	5,399,000
1934	63,247,423	25,731,000	27,465,423	10,051,000	3,369,000	6,682,000
1935	75,961,650	36,480,000	29,082,106	10,399,544	3,750,000	6,649,544
1936	98,304,208	51,430,000	34,644,564	12,209,644	3,820,000	8,389,644
1937	92,055,700	50,265,000	28,371,428	13,419,272	3,735,000	9,684,272
1938	74,690,000	34,215,107	30,491,393	9,884,000	2,700,000	7,284,000
1939	100,000,000					
1940	110,000,000					

Figures not available

Listener Density and Licence Fee

The radio has established itself as a feature in the life of several million people in the world. As has been stated already, by the end of 1941 there were 57 million radios in 90 per cent. of the homes (30.3 million) in U.S.A. This is only an estimate; accurate data could not be secured in the absence of licence figures and there is no licence fee in that country. In every other country in the world, a licence fee is levied, which goes towards the financing of the broadcasting organizations. The *British Broadcasting Corporation, London*, used to derive a certain percentage of its income from the radio licence fees.

The licence fee charged in different countries of the world is given in Table III.

TABLE III.

Country	Annual licence fee in local currency	Annual licence fee in Indian currency (approx.)
		Rs. a. p.
(1) U.S.A.	Nil	Nil
(2) Great Britain	£0-10-0	6 11 0
(3) Germany	24 R.M.	27 6 0
(4) U.S.S.R.	24 roubles	33 13 0
	{ 90 francs	10 11 0 }
(5) France	{ 15 francs for a crystal set	1 12 6 }
(6) Italy	81 lire	12 2 0
(7) Japan	6 yen	7 10 0
(8) Turkey	5L to 10L	60 10 0
		to 121-3-0
(9) Egypt	80 Piastres	10 1 0+
	+50P/Valve	0-11-0 per valve

It may be supposed that the annual licence fee and the cost of a set determine the number of radios in use in a country. This does not appear to be the case. The licence figures appear to depend on the cultural level of the population, the general economic level of the people and the type and technical efficiency of the broadcasting service. Table IV gives the licence figures during 1940 and 1941 in the U.S.A., seven different countries of Europe, and India. The same table also shows the listener-density, i.e., licensees per thousand of the population.

The number of receivers in Europe² at the end of 1941 was given as 51,794,499 or an increase of 2,458,447 over the number in the previous year. With an average of four listeners to each receiver, the total number of listeners in the European zone was about 207,177,996 or roughly 207.2 millions. The following table gives the number of licences in Great Britain and India.

There is a fall in the licence figures from 1939 to 1942 in Great Britain; it is not clear whether this is due to saturation being reached, or as a result of the war. There was an increase in 1943 and 1944. In India, saturation is far off. Taking into consideration every possible factor, it is estimated that a radio receiver density of 20 to 25 per 1,000 might be the saturation limit in India, as compared with 180 to 240 in the advanced countries. More receivers (either of the primary or secondary nature) would mean a greater volume of production of receivers and tubes. Thus, on the one hand, the industry will expand with its increased output and, on the other, the broadcasting organizations will increase their income, which will enable them to give better programmes, invest more on new and better equipment and open more stations to meet the increased number of listeners.

Radio Industry Should Expand

*The American Method*³.—The development of the radio industry in the U.S.A. forms a great chapter in the industrial history of America. To meet the needs of the domestic radio service the electrical industry of the U.S.A. (the *R.C.A.*, the *I.G.E. Company*, and the *Westinghouse Electric and Manufacturing Company*) undertook the task of creating a listening public. This is analogous to the publishing industry undertaking the task of educating the public with a view to create an expanding class of readers for their publications. Broadcasting is made

TABLE IV. Table of Radio Licence Density in 1940 and 1941.

Country	Licences at the end of		Density at the end of 1941	Rank as per radio density
	1940	1941		
U.S.A.	?	57,000,000*	438.5	1
Sweden	1,470,375	1,550,691	234.4	2
Denmark	?	?	233.91	3
Great Britain	9,132,200	8,625,579	187.51	4
Germany (including Austria)	14,965,048	15,843,144	177.48	5
France	5,133,035	5,262,642	Correct figures of population not available and hence density could not be calculated.	
Italy	?	1,674,546		
Holland	1,540,626	1,531,791		
U.S.S.R.	10,551,361	?		

* Total number of sets.

TABLE V. *Table of Licences in Great Britain and India.*

Great Britain			India		
On 31st	December		On 31st	December	
	1923	527,000	1927*		3,594
	1924	1,130,260	1928		6,152
	1925	1,664,320	1929		7,785
	1926	2,178,430	1930		7,719
	1927	2,395,100	1931		8,056
	1928	2,680,000	1932		8,557
	1929	2,956,340	1933		10,872
	1930	3,411,910	1934		16,179
	1931	4,329,150	1935		24,839
	1932	5,262,950	1936		37,797
	1933	5,974,150	1937		50,680
	1934	6,780,570	1938		64,480
	1935	7,415,700	1939		92,782
	1936	7,960,570	1940		1,19,407
	1937	8,480,822	1941		1,47,121
	1938	8,908,366	1942		1,65,583
September	1939	9,031,000	1943		1,76,061
July	1940	9,132,200	1944		1,93,506
	1941	8,625,579			
August	1942	8,836,724			
August	1943	9,250,000			
November	1944	9,609,503			

* The Bombay Station of the Indian Broadcasting Company was inaugurated on 23rd July 1927.

to pay in the U.S.A. even in the absence of the licence fee, by the levy of a charge on the use of the microphone in the same way as the telephone company imposes a charge on the user of a telephone. Sponsored programmes are characteristic of the broadcasting service in the U.S.A., though this system is viewed with disfavour in most other countries. The *American Telephone and Telegraph Company*, an associate of the *Bell Telephone Company*, started sponsored programmes in the U.S.A. as early as 1924, and laid the foundation for a unique radio industry in that country.

*The German Method*².—Germany was the pioneer in attempting the manufacture of *Volksempfänger* or the cheap people's receiver, simple in design and capable of receiving the nearest home station, so that the bulk of the population could afford the means to buy it. The success of the experiment can be gauged by the fact that 3 millions of such receivers were sold in five years. The first version of the people's set was a 2-tube regenerative detector with an electromagnetic speaker, costing 76 Marks or approximately £3 15s. This was later on reduced to 65 Marks or £3 5s. Still later, a cheap AC/DC midget version (model D.K.E.) was produced and sold at 35 Marks or about £1 15s. All the sets had bakelite cabinets. The German People's set was designed by a State official; the manufacture of the components was allotted to 28 different electrical firms, each specializing in one particular component; the *Telefunken Company* was entrusted with the production of special valves. All the components were sold at cost price to the Government assembly

factory. Each component was tested at the *Hertz Institute, Berlin*, before assembly.

Before the introduction of the People's set, the prices of German radios were considerably in excess of world prices. The State undertook to assemble the people's sets by inviting tenders for the various components, controlling the prices of the finished sets, cutting down distribution costs, avoiding profiteering, jobbers and middle men, and eliminating patent and licence rights. The prices were thus brought within the reach of the people. Similar attempts were made in other countries, notably in Italy, Switzerland, and Norway, but without success. The people's sets were successful in Germany from the very start but they were almost unsaleable in other countries. Curiously enough, trade figures show that, in spite of the enormous number of people's sets sold, the sale of the more expensive types was not affected. Germany initiated a drive also for the people's car, and a cheap automobile-superhet version of the people's set was produced for use in the car.

Manufacture and Raw Materials

There are two classes of radio manufacturers: (1) those who manufacture components and assemble them in accordance with the designs of their own engineering departments and (2) those who manufacture only the components.

There are in every country specialist firms engaged in the manufacture of individual components.

In the U.S.A.:

Solar, Dubilier, T.C.C., etc., for condensers;

Eerie, Ohmite, for resistances;

U.T.C., Thordarson, for transformers and chokes;

R.C.A., G.E., Philco, Sylvania, etc., for valves;

In England:

Marconi, Osram, Mullard, Brimar, Hivac, etc., for valves;

In Germany:

Telefunken for valves;

In pre-war Holland:

Philips for valves and components.

In recent years there has been a growing tendency to buy valves from a single standard firm like the *R.C.A.*, so much so that in 1940, 20 different radio receiver manufacturers used 27 million *R.C.A.* preferred type tubes in 5 million radio receivers, representing nearly half the industry's total output for that year.

It is recognized by every radio manufacturer that a good research and development department is essential for ensuring his prosperity. Royalty on patents has been called the invisible item that goes into the cost of a radio set. Several manufacturers pay the *R.C.A.* and *Marconi's* (who have taken out several thousands of patents) a certain per cent. on the total sales. The manufacturers realized that it is to their mutual benefit, to pool their patents and freely exchange patent rights, thereby reducing unhealthy competition and costs of production.

In the pre-war days a U.S.A. factory could produce as many as 5,000 radio sets per day. Such a concern would use 125 tons of steel (sheet steel for chassis and metal parts, and silicon steel for transformers), 100 car loads of lumber for 5,000 consoles and packing cases, 50 drums of paint and varnish, 5,000 lbs. of paper for condensers, 36,000 lbs. of wax paper for condensers and transformers, one car load of glass for tubes,

8,000 lbs. of brass, 10,000 lbs. of aluminium and 34,250 miles of copper wire (mostly enamel covered). 32 cars, each carrying 160 crated receivers, leave the factory for the jobbers and distributors. The production involved 990 operations. 10,000 employees were engaged in producing 5,000 sets, i.e., on an average two employees per set. These figures give a picture of the magnitude of the industry, its daily output, operations involved and the immense variety and quantity of raw materials required.

An analysis of the costs of various types of sets reveals the following average values for the components in a 5 to 7-valve set.

TABLE VI. *Table of Percentage Cost of Various Components in a Radio.*

Components	% of the total cost
Resistances, condensers and switches	10
Valves	10
Power transformers	7
Loudspeakers	11
I.F. transformers	7
Tuning coils	7
Dial and drive details	5
Cabinet, packing and sundries	6
Wages, power, propaganda, royalties, overhead, etc.	37
Total	100

The representative retail prices of component parts obtaining in the U.S.A. in late 1941, are given in Table VII.

TABLE VII. *Retail Prices of Radio Components.*

Carbon resistances . .	$\frac{1}{2}$ watt and 1 watt (any value) 2.5 to 3 cents or Re. 0-1-3 to Re. 0-2-0.
Paper condensers (200-600 volts) . .	6 to 17 cts. or Re. 0-3-0 to Re. 0-8-6 depending on value and voltage rating.
Electrolytic condensers. . .	25 to 80 cents or Re. 0-12-6 to Rs. 2-8-0 depending upon capacity and voltage rating.
Valves—	
(a) Glass	40 cents to \$1.35 or Re. 1-4-0 to Rs. 4-0-0.
(b) Metal	50 cents to \$1.35 or Rs. 1-9-0 to Rs. 4-0-0.
(c) Ballast tubes	40 cents or Re. 1-4-0.
Dial lamps	5 to 10 cents or Re. 0-2-6 to Re. 0-5-0.

TABLE VIII. *Table of Raw Materials Required for Radio Receiver Manufacture.*⁴

No.	Component	Materials required.
1.	Air core coils and transformers	Aluminium, brass, cadmium, copper, nickel, ceramics, cotton, paper, plastics, rubber, silk.
2.	Iron core R.F. coils and transformers	Aluminium, brass, cadmium, carbon, copper, iron and steel, zinc, ceramics, cotton, plastics, rubber.
3.	Iron core A.F. coils and transformers	Aluminium, brass, copper, iron, steel, nickel, zinc, cotton, paper, plastics, rubber, silk.
4.	Variable tuning condensers	Aluminium, brass, iron, steel, ceramics, plastics.
5.	Mica and paper condensers	Aluminium, copper, tin, ceramics, paper, plastics, mica.
6.	Electrolytic condensers	Aluminium, cadmium, copper, zinc, plastics.
7.	Carbon and wire wound resistances.	Aluminium, brass, carbon, copper, nickel, tin, ceramics, cotton, mica, paper, plastics, silk.
8.	Volume and tone controls	Aluminium, brass, cadmium, carbon, copper, iron, steel, nickel, plastics.
9.	Loudspeakers and head phones	Aluminium, carbon, cobalt, copper, iron, steel, nickel, cotton, mica, paper, plastics, rubber, silk.
10.	Thermionic tubes	Aluminium, cadmium, carbon, chromium, copper, iron, steel, molybdenum, nickel, tantalum, tin, tungsten, ceramics, mica, plastics.

The essential raw materials required for the radio components are tabulated in Table VIII.

Many of the raw materials listed in Table VIII are available in India. Unfortunately the equipment and skilled technicians required for the manufacture of the components are lacking.

Future Trends

The basic principles of radio and electron tubes are well established. The two major developments in the near future will be ultra-high frequency broadcasting using frequency modulation and television. Great as the development of the radio industry has been during the last two decades, even greater will be its development in the post-war years, due principally to the advent of frequency modulation. In the beginning of 1941, there were only 15,000 F.M. sets in use in the U.S.A.; in February 1942 over 120,000 F.M. receivers were in use! A huge ancillary industry of television-sound receivers will also arise. For two or three years immediately after the war, the industry will be fully employed in replacing obsolete broadcast receivers and manufacturing the components required. Within three years after the close of the war, the average receiver in the West would be designed for receiving frequency-modulated broadcasting, televised pictures and gramophone with automatic record changing, with facilities for recording as well. This will be marketed at a price which will be within the reach of the average citizen.

So far as India is concerned, there is no radio industry of any magnitude in this country at the moment. It is hoped that such an industry would be established at an early date. There would be need for three types of sets in India:

- (1) People's receivers and Folks' set
- (2) All-India receiver
- (3) All-wave receiver

The production of such sets at the prices mentioned will be feasible if all the components are manufactured within the country.

The high import duty of 48-60 per cent. on British and American sets, which is now imposed, should considerably aid the industry in its initial stages. It must be remembered that the success of broadcasting in India is primarily dependent on the availability of cheap receivers.

In a country like India, F.M. broadcasting would be really welcome. Even in the U.S.A. frequency modulation is still in its infancy and it would take at least a few years before frequency modulation can be expected to displace, if at all, the existing amplitude modulated transmitters. The total scrapping of all the A.M. transmitters would become necessary. In view of this difficulty, especially in a country like India, where organized broadcasting is still in its initial stages, the cost involved in scrapping the existing amplitude modulated radio receivers, the old transmitters and erecting new F.M. transmitters would not be easy. As regards television, it is still in the development stage both in England and in the U.S.A., the chief problem to be encountered being the extension of the existing small range and cheapening the cost of television-sound receivers. The price of such a receiver in England before the war was about £40, a price which was beyond the reach of the average man.

Acknowledgments

The thanks of the author are due to the Government of Madras for kind permission to publish this paper, and to the sources mentioned below for valuable information.

References

1 *Proc. of the Institute of Radio Engineers, New York* (several volumes).

2 *Wireless World*, London.

3 *Radio and its Future*, edited by Martin Godel (Harper Bros., New York).

- 3 to 5 valves, somewhat similar to the German; retail price, about Rs. 25-30.
- 5 to 7 valves, capable of receiving any Indian station; price about Rs. 75.
- 9 valves for receiving any station in the world, with refinements; price about Rs. 125-150.

4 *Electronics* (McGraw Hill Publishing Company, New York).

5 *Sylvania News* (U.S.A.),

REVIEWS

Modern Plastics. By HARRY BARRON (Chapman and Hall, London), 1945. Pp.xv+680, Price 42s. net.

SEVERAL publications on the subject of plastics have made their appearance in the U. S. A. and the United Kingdom. The appearance of the volume entitled *Modern Plastics* by Dr. Harry Barron is both timely and fortunate. By omitting materials such as shellac, bitumen and rubber plastics from the book Dr. Barron has been able to devote more space to the main stream of current plastic development. This is not altogether a mistake, although the reviewer is disappointed in the author's decision to exclude the silicon resins from his book. It is unfortunate that England is behind America in the matter of the application of these resins, but the argument of unavailability is really an argument in favour of its inclusion in the book. If the U. K. is to lead, people must be educated in the uses and methods of making them on a large scale.

The book deals with most of the well-known thermoplastics and thermosetting plastics. It has been divided into six parts.

Part I deals with the common properties and classes of plastics. It touches upon the historical background of the plastics industry, its development both in size and scope, its application to war tasks and its future. It also deals with raw materials for plastics and gives an elaborate account of coal, water gas, acetylene, oil, oil wastes, natural gas, cracked by-products of petroleum, ethylene, agricultural sources and cellulose derivatives, butylene, furfural, soya-bean, lignin, phenol and formaldehyde, etc., and their properties which result in their utilization in the plastics industry. This part also deals with such subjects as co-polymerization, cross-linking and branching, quite adequately. We would have wished this treatment to be a little more exhaustive as it is fundamental to the subject of plastics.

Part II deals with the thermosetting resins and their plastics in which are included phenolic resins and their applications, moulding powders, moulding phenolic resins, urea-formaldehyde, melamine-formaldehyde resins, cast resins, laminated materials and plastics and laminated wood. A wealth of information is displayed in the treatment, and important subjects such as preparation

of buttons and buckles, building boards, laminated plywood, electrically conducting glues and adhesives, etc., are described in great detail and in a language which immediately commands the attention of the reader.

Part III deals with cellulose plastics and includes such subjects as cellulose nitrate, cellulose acetate, injection moulding process and the manufacture and applications of ethyl cellulose. In these chapters substances such as celluloid, synthetic leather, cellulose foils and films, insulation sheets, etc., are fully described.

Part IV deals with vinyl plastics and deals exhaustively with the methods of polymerization, manufacture and uses of polyethylene, polystyrene and polyvinyl chloride and its derivatives. In this part of the book a fairly complete account of plasticizers and their application has been provided for the reader. This part also deals with acrylic resins, methacrylic resins, polyvinyl acetate and its plastics and such applications as manufacture of optical glass, vinyon threads, safety glass and laminated safety glasses. A full account of waterproofing qualities of these resins has also been provided.

Part V deals with other leading plastics such as polyamide plastics including nylon, alkyd and glyptal resins, casein, soya-bean and other plastics. The applications and uses of these are fully described. Particular attention has been devoted to wool-like protein fibres.

Part VI deals with some important aspects of plastics such as the use of high frequency heating in plastics, its principles and uses, as well as analytical methods useful for research and testing. A full account is provided of the tests and identification methods for various types of plastics and plasticizers. The physical tests for plastics are described in great detail and such properties as tensile strength, water absorption, volume and surface resistivity, shrinkage and cold flow, are fully described and explained in such a manner that even a beginner will be able to follow the subject without much difficulty.

The author repeats the valuable advice to the reader that an ounce of practice is worth a ton of precept. It is possible that this book itself may be considered by some as a lengthy precept, but there is no doubt that it will

lead ultimately to a great deal of practice of a useful type in the realm of plastic industries. The book is illustrated with excellent drawings and flow charts. Both theory and application are treated with extreme care, and the book is a mine of information for all serious students of this fascinating subject.

The book provides a large number of references, although these are by no means exhaustive. The author admits that his book is not meant to be an exhaustive treatment of the subject as he believes that a separate book covering as many pages as this book can be written on any one of the plastics treated in the book.

The printing and the get-up of the book are excellent and do great credit to Messrs. Chapman and Hall, Ltd. In spite of war difficulties, the materials used are fairly satisfactory. The book is singularly free from misprints and I feel confident that every student of plastics would like to possess a copy of this interesting book.

S. S. BHATNAGAR.

A Plan for Developing Fisheries in India. By E. V. S. MANIAM, Bureau of Economic Research, Cawnpore. U. P. 1945 (Patt & Co., Cawnpore), Pp. 18.

Several fishery experts have drawn attention to the richness of Indian fisheries and the need to develop and organize fishing industries to supplement the food resources of the country. Earnest efforts are being made in this direction by the Central Government as well as by several Provincial and State Governments. Mr. Maniam's booklet has a topical interest.

The author has given short accounts of the fishery resources, types of fisheries, food value of fishes, by-products and allied industries, canning and preservation, and other matters relating to fisheries and the fishing industry. A brief summary of the recommendations of the Fisheries Sub-Committee of the *Policy Committee of Agriculture, Forestry and Fisheries*, and a review of the progress of work of the Fisheries Departments in certain Provinces and States, are also given.

From the title of the booklet, one would expect to find concrete proposals for the development of fisheries in India, but no plan has been suggested. An attempt has been made to collect together information from various resources. As an economist the author would have done well to confine his effort only to the economic aspects of the fisheries problem. By attempting to write on such technical matters as live fishes, trout farms and hatcheries, habits and inclinations, longevity and mortality and other subjects, he has neither enriched the literature on fisheries nor has he brought any enlightenment to his readers. The titles in certain cases have hardly any relation to the subject matter dealt with. Anyone who knows anything at all about Indian fisheries will certainly not agree with Mr. Maniam's statement that the working of fisheries is a *very simple* affair. There are numerous intricate problems relating to fish and fisheries in India which demand expert knowledge and expert study. There are a few technical errors and several mistakes in the spelling of words.

B. S. B.

ATOMIC BOMB RESEARCH

The team of British scientists who, since 1943, have been working on the atomic bomb in collaboration with American scientists at the University of California Radiation Laboratory. In the centre pointing is Dr. Ernest O. Lawrence, head of the laboratory. At the far left is Dr. H. W. S. Massey, head of the British group.



NOTES AND NEWS

Physical Properties of Textile Fibres :

Recent Work at Shirley Institute

EMPIRICAL knowledge gained through long experience has largely determined the uses to which natural fibres are put. Quantitative data relating to the properties of textile fibres have assumed importance, as they provide a basis for assigning optimum uses for a given fibre and also for ascertaining whether a given fibre can be substituted for another. Considerable work on the tensile behaviour of raw cotton and other textile fibres—rayon, silk, bast fibres, wool and synthetic products—have been carried out by the British Cotton Industry Research Association, and the results obtained are published as a memoir (*Shirley Institute Memoirs*, 1944, 19, 5). The results are of considerable value to the technologist who seeks to build fabrics for special purposes. Long fine cottons are found to possess a greater specific strength than short coarse varieties. The stress-strain curves for all the samples are nearly similar in shape, but the initial Young's modulus for the finer cottons is considerably greater. Rayons differ very much in their values for fineness, specific strength, percentage of extension at break and the initial Young's modulus. Compared to the coarser rayons, the finer samples are found to have less extension at break. The stretched rayons, which are all generally fine, are the strongest in this group. With regard to silk and nylon, the Chinese silk, besides being stronger, has a greater initial Young's modulus than the Italian or the Japanese silk. Nylon with the same extension at break as silk, is stronger; its initial Young's modulus, however, is lower.

The specific strength of wool is found to be independent of fineness. From the point of view of strength and work of rupture, camel hair is superior to wool, and consequently, it can be used for cord belts. Fibres of the casein group, on the other hand, are remarkable for their weakness and plasticity. Bast fibres are characterized by low extensibility and low work of rupture. A comparison of the tensile behaviours of different fibres reveals that the specific strength is very high for ramie, stretched rayon and flax, whereas it is low for acetate rayon and casein fibres. The least extensible fibres are the bast fibres, while the greatest amount of extension is shown both by wool and the casein fibres. Silk and nylon combine high strength with a high degree of elasticity. With some exceptions, the strongest fibres are found to be the least extensible. Greater variability is usually exhibited by the natural fibres than by artificial ones.

The tensile elasticity or elastic recovery of textile fibres, which can be defined as the ratio of total extension to permanent extension, (*Shirley Institute Memoirs*, 1944, 19, 29) varies considerably. Of all the fibres examined, nylon, stretched rayon and flax have a higher capacity to recover from a given stress than others. The elastic recovery for a given strain is found to be the greatest for nylon and wool.

Observations relating to the effect of colour on the absorption and emission of radiation by a textile

fabric, have been reported in another *Memoir* issued by the Shirley Institute (1944-45, 19, 59). The experiments were undertaken with the threefold object of finding the colour best suited for (a) protection against solar radiation, as in the tropics, (b) reduction of heat loss from the body, as in cold latitudes, and (c) camouflage purposes. Three sources of radiation, viz., (1) a high intensity arc giving a spectral distribution similar to sunlight (2) an electric radiator at 900° C. and (3) a copper cylinder kept at 36° C. corresponding to the temperature of the human body, were employed. For measuring the absorption of energy, a pair of Kata thermometers was used in the case of the first two sources, while in the third case, a Moll micro-thermopile was employed. The material studied consisted of bleached poplin as such and dyed in various colours. Different black and khaki dyes were tried as also an aluminium foil. The results obtained show that for maximum protection against the tropical sun, and if camouflage is not necessary, a white fabric lined inside with aluminium foil would be most suitable. Among the coloured fabrics, marked differences were observed in the absorption of fabrics which to the eye appear to be roughly alike, the differences observed being probably due to the differences in the absorption of the radiation in the near infra-red region. Hence for protection against solar radiation, the dye which absorbs the least amount in the near infra-red should be selected, and luckily this condition is linked with the requirements for camouflage purposes, namely, indistinguishability even in infra-red photographs.

With regard to the question of heat loss from the body, no relationship has been found between the colour of the fabric and the emissivity at 36° C. The aluminium foil, however, was found to have very low absorption and emissivity.

The rate of evaporation of water from a plane moist surface is influenced by textile fabrics which are in contact with it. A quantitative study of the change in the rate brought about by the fibres has been carried out by Rees (*Shirley Institute Memoirs* 1944, 19, 47) with the help of a specially designed apparatus consisting of a hollow cylindrical brass vessel with a circular porous lid, 2" dia. fixed in position with picein wax. The vessel is filled airtight with distilled water and connected to a graduated capillary tube set horizontally at the same level as the lid of the porous plate. As the water evaporates from the surface of the porous plate, water flows from the capillary tube into the vessel, and by observing the rate of movement of the meniscus in the tube, the rate of evaporation from the plate is determined. After the rate for the base plate is obtained, the fabric is placed in contact with the porous plate and clamped in position. The test is continued until a steady value for the rate of movement of the meniscus is obtained which generally takes half an hour. The rate of evaporation is given in cubic centimetres per square metre of fabric per second. The apparatus is housed in a constant temperature and humidity chamber.

Experimental data obtained for three cellular (leno-weave) cotton fabrics, two plain (close and open) weave cotton cloths in scoured and bleached states and with water-repellent finish in single and double layers, are given in the *Memoir*. Tests with artificial acid perspiration liquor instead of distilled water, showed that the water-repellent fabric has the same tendency to wet out with the liquor as with distilled water. It is suggested that for next-to-the-skin garments, an absorbent material of fairly open texture is desirable and that a water-repellent finish should be avoided.

The same apparatus, with some modifications, can be employed for measuring the water vapour permeability of textile fabrics. (Peirce, Rees and Ogden, *Shirley Institute Memoirs*, 1944, 19, 51.) A cylindrical porous pot, 10" long and 2.8" dia., whose flat end is made impermeable to water-vapour by a thick layer of picein wax, is used in place of the brass vessel with the porous lid. The curved surface is covered by a thin sheet of cellulose acetate and the joins and edges are sealed. The fabric under test was wrapped round the cellulose acetate, which serves as a semi-permeable membrane allowing water vapour to diffuse but preventing the passage of liquid-water. A single test takes about 3 hours.

The test results are expressed in resistance units of R. H.

grams/metre²/sec. The results show that a water-repellent finish has no deleterious effect on the transmission of water-vapour through a fabric. The vapour permeability of the doped fabric is about the same as that of the undoped fabric. The diffusion of water-vapour through a fabric occurs not only through the interstices but also through the fibres themselves, the latter becoming quite predominant in very close weaves. A theoretical analysis of the mode of flow of water-vapour through a fabric is included in the *Memoir*. The resistance of the fibre is found to be roughly 12 times that of air. Nylon fibre possesses a high resistance as compared to that of cotton or wool fibre.

If the temperature of the water in the porous pot is known, the resistance may be expressed in terms of vapour pressure

grams/metre²/sec.

The Structure of Cellulose Rayons.—The chain lengths of cellulosic materials can be determined from the viscosity-concentration relations of their solutions by applying the Staudinger equation

Lim

$$\lim_{c \rightarrow 0} \eta_{sp} = K_m l$$

Where η_{sp} is the specific viscosity of solution of concentration expressed c.g.m. per litre, l is the mean chain length in glucose units and K_m is a constant depending on the solute, solvent and temperature.

The values of K_m for cellulose acetates dissolved in different organic solvents and in cuprammonium hydroxide have been determined (Howlett, Martin and Swan, *Shirley Institute Memoirs*, 1944, 45, 19). The value of the constant for secondary cellulose acetate in acetone solution was found to be 4.3×10^{-4} while that for cellulose in cuprammonium hydroxide solution was 2.5×10^{-4} .

The chain length of a viscose rayon was determined by acetylating the viscose and subsequently deter-

mining its viscosity in chloroform and *m*-cresol, the values found being 506 and 493 respectively. The mean value agreed with the value obtained by dissolving the material directly in cuprammonium hydroxide.

By applying Staudinger's equation, the value of K_m for acetylated viscose was found to be 2.33×10^{-4} . The values for triacetates prepared from Bemberg and Tenasco were 2.39×10^{-4} and 2.46×10^{-4} respectively and for cellulose acetate, dissolved directly in cuprammonium hydroxide, the value is about 2.4×10^{-4} .

Secondary cellulose acetates of different molecular chain lengths are usually present in cellulose acetate. In 1930, Rocha isolated three fractions varying in viscosity but of the same acetic acid yield. The same method was used by Herzog, who obtained nine fractions giving the same acetic acid yield, but with molecular weights varying between 19,000 and 74,000. Rutherford, Mark and Harris obtained by repeated precipitations from acetone solution with ethyl alcohol, 15 fractions having chain lengths varying from 30 to 380 glucose units. The acetic acid yield was the same for all fractions except three which possessed very low chain lengths.

In any study on the structure of rayon, it is of obvious interest to evolve a suitable fractionation technique for preparing a homogeneous product. A detailed investigation of the solubility of a cellulose acetate rayon in a series of mixtures of a solvent with a non-solvent, has been made by Howlett and Urquhart (*Shirley Institute Memoirs*, 1944, 19, 79), mainly with the object of evolving a suitable fractionation technique and, incidentally, to ascertain to what extent information about the chain length heterogeneity of the material could be derived directly from solubility curves.

Solubility curves were obtained by dissolving cellulose acetate in varying proportions of acetone and a non-solvent like methyl alcohol, ethyl alcohol, iso-propyl alcohol, benzene, *n*-butylacetate and carbon tetrachloride. Similar solubility curves were determined with solvents like methyl ethyl ketone and non-solvents like methyl alcohol and ethyl alcohol. The changes in the solubility curves accompanying the degradation of cellulose acetate by oxidizing agents were also investigated, in order to find out the slope or shape of the curves due to the lowering of chain lengths. The solubilities of samples oxidized with sodium hypochlorite in a mixture of methyl ethyl ketone and ethyl alcohol were determined at 25° C. and 60° C. The information provided by the solubility curves led to the development of a fractionation technique using acetone as solvent and *n*-butyl acetate as diluent, and this was employed to fractionate a commercial secondary cellulose acetate (seraceta) and an oxidized product obtained from it. It was found possible to obtain from seraceta, six different fractions by using different solvent mixtures. The solubility curve can be used to select a suitable solvent mixture to give a fraction of the desired chain length. The cellulose acetate progressively loses its shorter molecules during the process of fractionation. The fluidities of 2 per cent. solutions of the different fractions in cuprammonium hydroxide solution decrease regularly from the first to the sixth fraction indicating that the mean chain length increases in the same direction.

H.N., R.L.N.I., V.V., D.L.S.

The Preparation and Storage of Adhesives

A review of all available information on the preparation and storage of adhesives has been published by the *Printing and Allied Trades Research Association*, London (1945). Depending upon the raw materials employed in their preparation, adhesives can be classified under ten heads, viz., (i) animal glues and gelatines (ii) blood albumens, (iii) fish glues, (iv) casein adhesives, including soya-protein adhesives, (v) vegetable adhesives, starch pastes, modified starches and dextrins, (vi) natural gums, (vii) rubber adhesives, (viii) synthetic resin adhesives—thermosetting and thermoplastic—(ix) cellulose adhesives and (x) sodium silicate.

These different adhesives find distinctive uses in industry. The main use for animal glue, for instance, is in the manufacture of cartons, rigid and folding boxes, bookbinding and showcard mounting. Flexible glues are made by the addition of a plasticizer like glycerine or glucose syrup to animal glue. Blood albumen glues are seldom used to-day, and fish glues are mostly sold as liquid glues and have been in favour for many years as the ideal adhesive for domestic purposes. The photo-engraving industry uses a considerable quantity of fish glue. Protein adhesives are used as extenders for other adhesives; they give joints of high mechanical strength. Vegetable adhesives are extensively used in the packaging industry. Natural gums are suitable for use as remoistening adhesives or as office mucilage and plasticizers such as glycerine or glucose syrup are often incorporated to make the film pliable on drying. Rubber adhesives and cements find use in the production of adhesive tapes, and for bonding rubber to metal or rubber to fabric or for joining hard plastics.

Various types of synthetic resin adhesives have come into use. In the thermoplastic class, vinyl, styrene and acrylic resin polymers are extensively used for joining cellulose films, glass, synthetic rubber films, etc. Of the thermosetting resin adhesives, special mention may be made of phenol-formaldehyde and urea or thiourea-formaldehyde resins. Cellulose adhesives are transparent and both cellulose nitrate and cellulose acetate are used in making them. Methyl and ethyl cellulose have also come into use for preparing a new class of adhesives. Sodium silicate is an inexpensive adhesive for the production of corrugated paper, laminated boards or paper, paper tubes, fibre-board containers, etc.

The handling and storage of adhesives need special care. Scrupulous cleanliness, temperature and humidity control and good ventilation in the store room are essential to avoid waste.

P. K. B.

Indian Woods for Battery Separators

The results of a detailed investigation carried out with a view to testing the suitability of a few Indian woods for battery separators are contained in a Bulletin entitled *Indian Woods for Battery Separators*, published by the Wood Seasoning Section of the Forest Research Institute, Dehra Dun.

Out of the Indian woods tested, Cypress (*Cupressus torulesa*) and Champ (*Michelia Champaca*) are as good as the imported wood, Port Orford Cedar, for battery separators.

The batteries fitted with the separators made of the woods to be tested were subjected to accelerated

cycles of charge and discharge. A complete record of the specific gravity of the electrolyte, its temperature, and the voltage of the cells was maintained. The cells were also tested for maintenance of charge on open circuit, internal resistance, discharge at high currents, etc. The batteries fitted with the imported Port Orford Cedar were used as controls.

Molassic Manure

Molassic manure is obtained by the fermentation of a mixture of molasses and filter-press cake. The method consists in developing yeast in the sludge which is separated and dried in sun-drying beds, giving a black manure having high nitrogen, phosphorus and potash contents. It may also be called Yeast Cake like castor cake and mahua cake.

The direct application of molasses to the soil as manure has been a subject of investigation for a fairly long time, both in India and abroad. The dubious results obtained may be attributed to the inhibitory effect on plant growth of the acids produced by fermentation of molasses in the soil. When molasses is applied in small doses, and the alkalinity of the soil is sufficient to neutralize the acidity produced, the deleterious effect is not so evident; but when it is applied in large amounts, the retardation of the plant growth becomes significant. The reactions taking place in the soil on direct application of molasses seem to be very complicated. Nitrogen fixation has been noted in some cases and nitrogen loss in others. There are other practical difficulties in the direct use of molasses as manure. Thus it has to be applied in a diluted form and large quantities of water are necessary for the purpose.

The difficulty and inconvenience of applying molasses directly to the soil and the dubious nature of the results obtained prompted investigations on the possibilities of converting molasses into a concentrated manure, which would be easy to transport and handle. A process has been developed at the *Imperial Institute of Sugar Technology*, which produces a yeast cell body (*S. Cereviciae*) by fermentation at neutral point under conditions of heavy aeration, the acidity being intermittently neutralized with milk of lime or soda.

Although molasses itself has very little value as manure, the molassic manure, which contains the biological products of fermentation, has a high manurial value. The nitrogen content in molasses is 0.25 per cent., while that of the molassic manure varies from 1.79 to 2.85 per cent. In addition to nitrogen the manure contains high percentages of phosphate and potash. It also contains plant hormones and auxins which promote vigorous plant growth in comparatively small doses.

It is computed that a plant attached to a 1,000-ton factory, and consuming all the molasses and filter-press cake produced by it, can make 300,000 mds. of manure annually. Assuming the nitrogen content of the manure to be 2 per cent., 6,000 mds. or 4,93,800 lbs. of N would be produced. On the basis of the recommended rate of 100 lbs. N per acre, nearly 5,000 acres of land can be manured from the product derived from a 1,000-ton factory.

Damodar Valley Authority

A series of reservoirs providing flood control, supply of water for irrigation, and a system of hydro-electric and thermal power stations interconnected by transmission lines, these are the main features of the *Damodar Valley Multi-Purpose Project*, out-

lined in a preliminary memorandum prepared by the Central Technical Power Board. A rough estimate of the capital expenditure involved gives a figure of Rs. 55 crores.

The memorandum deals with past floods, for which the Damodar River has an evil reputation, and discusses the "Design Flood" on which the outline plan is based. The general plan of development comprises the building of a system of eight dams and a barrage. Seven of these dams are for storage purposes, and hydro-electric generating plants will be installed at all the dams. The aggregate controlled reservoir capacity would be about 4,700,000 acre feet. Detailed studies indicate that the storage volume would be sufficient for all purposes.

Under the proposed plan of development, it would be possible to undertake the perennial irrigation of about 760,000 acres, including the 186,000 acres at present partially irrigated.

The project would make possible the development of about 65,000 continuous kilowatts of primary hydro-electric power and an additional amount of intermittent or seasonal power up to a further 65,000 kilowatts. The necessity of combining the hydro-electric plants which would contain about 200,000 kw. of generating capacity, with some 150,000 kw. of thermal generating capacity in large modern units, is emphasized. After allowing for losses, the system would be capable of meeting a maximum demand approaching 300,000 kw., making available about 1,420 million kw. hrs. annually.

The provision of a regulated flow would make practicable promising schemes of public water-supply to communities in its vicinity. Apart from domestic water-supply, the project will provide an ample supply of water for industrial purposes.

Administration.—In view of the multi-purpose nature and the vast scope of the project, it is felt that it should be constructed and operated under a single unified administration. The memorandum, accordingly, recommends that the task of planning, designing, constructing and operating the dams, reservoirs, waterways, power houses and transmission lines should be entrusted to an Authority with powers and duties carefully delineated by the Central Government and the Governments of Bengal and Bihar. It is suggested that a detailed examination of the *Tennessee Valley Authority Act* may be useful.

The project will vitally affect and reorientate the lives of about 5 million persons living in the Damodar Valley and about 2 million persons living in urban areas.

The August Conference.—The decision to proceed rapidly with further investigation of the united and multi-purpose Damodar Valley Development Project was taken at a conference between the Central Government and the Governments of Bengal and Bihar, which was held at Calcutta during the last week of August. The Hon'ble Dr. B. R. Ambedkar, Labour Member to the Government of India, presided.

Further investigation of possible dam sites on the Damodar River will be necessary before starting actual construction. Among the sites which require such investigation are Maithon, Aiyar and Sonalapur. The conference discussed the technical aspects of the question and decided that the order of priority for investigation should be Maithon, Aiyar and Sonalapur. The Central Technical Power Board would prepare project reports for each of these dam sites. In the case of the last site, the possible effects

on coal production will also be investigated. The Central Government would try to secure, at the earliest possible opportunity, the staff required for detailed investigations. In the meanwhile, investigations would be carried out by such staff as was immediately available.

It was decided to invite four engineers from the U.S.A. to advise on the design and construction of the first two dams to be built under the proposed united scheme. The engineers would constitute a Technical Mission and should arrive, if possible, in India early next year. It was hoped that by that time the required data would be collected.

While the ultimate intention is to constitute a Damodar Valley Authority for the administration and carrying out of the scheme, the conference decided that, as an interim measure, the Central Government should appoint a high ranking Administrative Officer for co-ordinating all preliminary action and for rapidly pushing through investigations connected with the proposed project.

It was agreed that investigations should be undertaken simultaneously for the various other problems connected with the scheme. The Irrigation Departments of the Bengal and Bihar Governments, in consultation with the Central Irrigation, Waterways and Navigation Commission, should investigate the best methods of utilizing the water made available for irrigation. Other subjects to be investigated include development of power demand including setting up of nursery stations, anti-erosion works, navigational, geological and water-supply aspects of the scheme and the layout of transmission lines.

Irrigation and Hydro-electric Research

With the concurrence of the Government of India, the Central Board of Irrigation has amended its constitution to admit, as ex-officio members, Chief Engineers in charge of hydro-electric projects in Provinces and in some of the Indian States.

Following the creation of the Central Waterways, Irrigation and Navigation Commission, the constitution of the Board has also been modified so as to admit, as ex-officio members, engineers, with the status of a chief engineer or higher, employed by the Central Government and dealing with matters concerning Indian waterways.

Irrigation and hydro-electric engineers are confronted with many problems in common and both would gain by mutual discussions and direction of research. The need for co-operation in technical matters has now become very important in view of the post-war multi-purpose projects for developing the water resources of the country, both for irrigation and power generation.

As a result of these amendments in the constitution of the Central Board of Irrigation, the future meetings of the Board will provide a common platform for heads of the irrigation and hydro-electric services of the Provinces, and some of the Indian States, and technical representatives of the Government of India.

National Physical Laboratory, India

An important step will be taken in equipping India in the matter of scientific and industrial research when the recommendations of a Committee appointed by the Council of Scientific and Industrial Research finally take shape. The Committee met in Bombay in August under the chairmanship of Mr. Ghulam Mohammad and finalized the report

on the establishment of a National Physical Laboratory. The tentative proposals of the Committee had been circulated to Universities, Scientific Bodies, eminent scientists abroad and in India. It is a matter of satisfaction that these proposals have found wholehearted support both in India and abroad from eminent scientists and others.

It has been decided to locate the proposed National Physical Laboratory (India) at Delhi, on a site already acquired for the purpose. The building and equipment are expected to cost about Rs. 40 lakhs, while the recurring expenses are estimated to be about Rs. 8 lakhs per annum. The laboratory will have the following eight sections:

- (i) Weights and Measures.
- (ii) Applied Mechanics and Materials.
- (iii) Heat and Power.
- (iv) Optics.
- (v) Electricity.
- (vi) Electronics and Sound.
- (vii) Building and Housing Research.
- (viii) Hydraulics Research.

The Laboratory will be the custodian of primary standards in India, and will undertake research on standards of measurement, quality, and performance, and on scientific and industrial problems falling within its purview. It will assist industrial organizations in drawing up specifications, in finding uses for Indian raw materials, in developing new processes of manufacture and in solving problems of industrial or applied character referred to it. It will undertake pure and applied research on all branches of physics, including the science of electronics which has assumed great importance in recent years.

Indian Central Sugar Committee

The decision to establish an All-India Sugar Technological Institute, linked with its own Agricultural Research Station, both being run under the Committee's direct control, was taken by the Committee at its meetings held at New Delhi from 11-18 August, under the chairmanship of Mr. H. R. Stewart. A special sub-committee was set up with Sir T. S. Venkataraman as the convener, to consider immediately the question of a suitable location for the combined institute and the agricultural research station and to make recommendations.

The Committee also decided to undertake an immediate survey of the causes of excessive fuel consumption in the majority of the Indian sugar factories with a view to make them self-supporting in fuel requirements by the use of bagasse only, as in the case of factories in Java and of a few factories in India.

The scheme of research on the improvement of *khandsari* sugar at the Research and Testing Station, Bilari, U.P., was extended for one year with special provision for confirming on a semi-commercial scale in the holdings of private farmers dealing with *khandsari* sugar, some of the improvements recommended by the Station. The Committee were informed that under the sugar-candy scheme financed by it, a new method of crystallization had been developed which would make it possible to produce candy on a commercial scale in future.

On the information placed before it, the Committee felt justified in recommending the practice of first-year ratoons and decided to finance schemes for working out practical cultural and manurial schedules for growing good one-year ratoon crops.

A joint meeting of the Panel on Sugar, Alcohol and Food Yeast (constituted by the Government of India, with Sir Shri Ram as President) and the Agricultural Research Sub-Committee of the Indian Central Sugarcane Committee, was held on the 14th August 1945, when important points relating to the possibility of developing early and late ripening varieties of sugarcane and of increasing the yield of cane per acre and the recovery of sugar from cane were discussed.

Standardization of Leather Production

"There is at present an acute shortage of raw hides suitable for the production of sole and upper leather throughout the world. It is very necessary to take steps to ensure that the limited supply of available raw hides are utilized to the best possible advantage," says a Press note dated 14th September, issued by the Supply Department.

"One very common source of wastage is faulty tanning and processing by small tanners resulting in the production of poor quality leather, which does not stand the same wear and tear as it would do if the hides were processed and tanned in the correct manner.

"So far as the production of sole leather is concerned, Government, in 1942, introduced control over the processes of tanning of certain tanneries producing sole leather in bulk and brought their processes to proper standards resulting in the production of better quality of durable sole leather.

"Government have now decided to introduce similar control over certain chrome tanners producing upper leather, especially in the Calcutta area, who process a very large number of raw hides and whose methods of tanning are wasteful and inefficient. It is hoped that with the exercise of the control the quality of leather produced by these tanneries will improve, resulting in increased quantities of leather being available for export."

Koh-i-Sultan Operations

The Central Government have decided to sell their properties and machinery attached to the Koh-i-Sultan sulphur operations in Baluchistan and stocks of sulphur ore lying at Nokkundi railhead.

These operations were started in 1941 and conducted by the Utilization Branch of the Geological Survey of India in the face of difficult climatic and regional conditions obtaining in Baluchistan. The deposits of sulphur ore occur at Batal, Miri and Nawar in the Koh-i-Sultan mountain. The sulphur deposits are of volcanic origin and include lenticular masses of ore cropping out at the surface and in some cases continuing downward beneath overburden which consists largely of loose volcanic ash.

In quality the ore varies up to over 60 per cent. free sulphur content. The high-grade ore has been used in the manufacture of sulphuric acid. Laboratory tests have shown that, by flotation, an appreciable improvement in the grade can be attained, but the process involves the use of expensive machinery.

Tests carried out by various Agricultural Departments have shown that the high-grade ore, when finely powdered, is very suitable for preventing certain diseases in grain crops. Most of the high-grade ore has been extracted from the Batal area, but at Miri large quantities of plus 50 per cent. ore have been uncovered ready for extraction. In addition there are indications that certain of the deposits continue within the hillside for distances greater than have so far been proved.

The main sulphur deposits at Miri are linked up by two-foot gauge tram-track to a monocable aerial ropeway, approximately 2 miles in length, along which the Miri ore is transported to the main road-head at Batal. The Miri-Batal ropeway is capable of transporting 15 tons of ore per hour to Batal and water and stores to Miri on the return.

The purchaser of these properties and machinery will have the right to work sulphur mines or dismantle the properties and to dispose of the stocks of sulphur ore as he thinks fit. Working the mines will, however, be in accordance with the Central Government Mining Rules.

Disposal of War Surpluses in India

Disposal of large quantities of scrap, salvage and surplus stores arising from the war is one of the major problems which India has to tackle along with other countries of the United Nations.

It is pointed out that the range is very wide and individual items may vary from a collection of steel scrap, to the most modern factories built for the production of war material and capable of easy conversion for civil industry. In terms of money the total value of stores to be disposed of may range from one to two hundred crores of rupees.

The Disposals Board set up by the Central Government in the fifth year of war has laid down the main lines of policy to ensure the orderly and efficient disposal of these surpluses. The principles underlying the operating policy are : (1) shortest and most direct approach to the ultimate consumer ; (2) use of established trade channels, etc., as far as practicable ; (3) regulation of the flow of surpluses so as to cause minimum interference with internal economy and production ; (4) wide distribution, so that the benefits are made available throughout the country ; (5) control, where practicable, of retail selling prices, in relation to current market prices, and (6) realization of the largest possible cash return.

The Disposals Board is a high-level body with the Secretary to the Government of India, Supply Department, as Chairman and the Secretaries of various other Departments concerned as members. The Directorate-General of Disposals, New Delhi, is the executive organization of the Board and is responsible for executive action in respect of all stores except in regard to disposal of articles of food and textiles, for which the existing organization of the Food Department and the Textile Commissioners are responsible. The Director-General of Disposals is also responsible for the disposal of factories and industrial units, but not for the disposal of other lands and buildings. The Controllers of Supplies (Disposals) at Calcutta, Bombay, Madras, Cawnpore and Karachi, and the Deputy Controller of Supplies (Disposals) at Lahore, act as regional representatives of the Director-General in all disposals matters.

The categories of goods dealt with can be divided into two broad classes, i.e., salvage and surplus stores. Salvage, again, can be split up into (a) process scrap, i.e., scrap arising from the manufacturing processes in industries, and (b) other salvage.

Salvage is sold at the Army Depots at Lahore, Jubbulpore, Lucknow, Cawnpore, Allahabad, Agra, Delhi, Ambala, Karachi, Quetta, Rawalpindi, Peshawar, Calcutta, Kanchrapara, Ranchi, Dhanbad, Gauhati, Chittagong, Dibrugarh, Jorhat, Imphal, Ahmednagar, Avadi (Madras), Bangalore, Bombay, Secunderabad, Ghorpuri, Deolali, and other centres.

Sales are usually by auction or by advertised tender. The main heads of salvage dealt with are : textiles, cotton, wool and silk—including cotton cuttings, cotton rags, garments, mosquito netting, felt cuttings, blankets, woollen rags, etc.—rubber, leather—including eather scrap from harness and saddlery factories, cuttings, shavings, pieces and bellies, unserviceable boots, *chaplins* etc.—paper, including waste paper, cardboard and other miscellaneous items.

Also included in items of salvage are M. T. parts and ferrous and non-ferrous scrap and aero-scrap.—M. T. parts include parts from breakdown depots consisting chiefly of radiators, axles, propeller shafts, unserviceable engines, springs, vehicles, lorries, cars and trucks, broken parts of ferrous and non-ferrous M. T. parts, etc. ferrous scrap, includes mild steel scrap consisting of angles, bars, rods, borings, turnings, sheet and plate cuttings, etc., tin scrap, binding wire and hoop iron, miscellaneous scrap consisting of aero steel scrap, fabrication scrap, galvanized iron scrap, nuts, washers, hinges, cooking utensils, miscellaneous hardware, etc.

It is pointed out that salvage can be put to many uses and that considerable progress has been made regarding the utilization of some of the salvaged materials in small industries. The large stocks of "dural" tubes usually available in aircraft scrap have been found suitable for the manufacture of tubular furniture. Aero-scrap is being used for cast ware work and a variety of utility articles can be produced from it, e.g., trays, plates, cutlery, mugs, ash-trays, picture and mirror frames, blotters, penholders, ink pots, coat hangers, hooks, paper weights, table lamps, window frames and fasteners, boot-trees, etc. Railways are already experimenting in the use of this alloy for the manufacture of carriage and wagon fittings.

The process of melting and manufacture is relatively simple. The finished article, to all appearance, resembles aluminium products. It is, however, emphasized that the alloy is not suited for drawing into sheets or, what is more important, for the manufacture of cooking utensils. Useful articles can also be made from aircraft parts without having to melt the alloy. At salvage depots are occasionally exhibited items like furniture, tyre pumps, rotating hospital lamps, ice boxes, buckets, *chaplins*, small tools, etc., all made from salvaged aircraft material.

The average sales of salvage amounted to about Rs. 28 lakhs a month recently. The total value of the sale proceeds of salvage from November 1943 to June 1945 was about Rs. 3,76,00,000.

Now that the war has come to an end, stores other than salvage will be declared surplus in increasing quantities, after ascertaining whether they are surplus to over-all military requirements.

The sale proceeds of surplus stores up to the end of June 1945 was Rs. 55 lakhs. This, however, represents only a very small fraction of the volume of work which will now have to be undertaken. The Director-General of Disposals is examining plans for the disposal of individual major categories of goods. It is emphasized that the method of disposal will vary according to the nature of the goods and the quantities in which they are thrown up for disposal. Goods needed for civil consumption of which there has been an acute shortage during the war, may be easily released without any untoward effects on the market. On the other hand, in regard to items where surpluses are likely to equal or exceed normal civil demands careful planning is needed to

ensure that their release is arranged in a manner which does not upset internal economy and industry.

The disposal of surplus factories is also engaging active attention of the Central Government and as soon as decisions are taken, wide publicity will be given to the matter.

Wheat Research in Australia

The New South Wales State Government's decision to establish a wheat research station in the heart of the southern wheat belt has as its primary objective the breeding of wheat of a superior baking quality. This is part of the Government's campaign to bring better bread to the public.

Next to wool, wheat is the most important primary industry in New South Wales.

It is many years since William Farrer cross-bred wheats and other cereals, and brought Australia into the vanguard as a producer of wheats of a high standard of quality and disease resistance.

The war largely held up research in Australia. The establishment of the new station will assist Australia to meet post-war competition for oversea markets.

Dictionary of Economic Products and Industrial Resources of India

The following articles have been received from external contributors for the *Dictionary* during the period 1st April—30th August 1945.

Botany.

Eugenia caryophyllata (Mr. A. K. Yegna Narayan Aiyer).

Panicum miliaceum (Mr. C. Vijayaraghavan).

Panicum miliare (Mr. C. Vijayaraghavan).

Carum copticum (Mr. V. A. Tamhane).

Chemicals

Dextrin (Messrs. B. Zaveri and S. Krishnaswami).

Menthol (Dr. S. S. Aiyer).

Geology

Coal in India (Mr. S. K. Roy).

Vanadium (Mr. Daya Swarup).

Quartz and other forms of silica (Mr. A. G. Jhingran).

Fuller's Earth (Mr. K. L. Bhola).

Industry

Perfumery Industry (Mr. Sadagopal).

Manufacture of Slate Pencils (Mr. N. N. Godbole).

Coal Tar and its derivatives (Mr. C. J. Fielder).
Manufacture of Locomotives (Mr. P. R. Agarwal).

Pottery (Note) (Mr. T. W. Talawalker).

Rolling Mills (Mr. N. B. Sinha).

Storage Batteries (Mr. J. D. Joglekar).

Zoology

Pearl and Pearl Fisheries (Dr. B. Sundara Raj).

Announcements

National Institute of Sciences.—The Government of India have recognized the *National Institute of Sciences* as the premier scientific body in India, and steps are being taken with the appropriate authorities in England to give it a Royal Charter.

Dr. S. Siddiqui, Officiating Director, Chemical Laboratories, *Council of Scientific and Industrial Research*, Delhi, has proceeded to the United Kingdom. He will be attached to the Dominion Scientific Liaison Offices in the United Kingdom and will represent the *Council of Scientific and Industrial Research, India*, in connection with the preparation of the agenda, etc., relating to the *Empire Scientific Conference* proposed to be held in the United Kingdom in July 1946.

Dr. J. W. Whitaker, Principal, Technical College, Huddersfield (England), has been appointed Director, Fuel Research Station, Dhanbad.

Mr. Y. P. Varshney, M.Sc., A.R.I.C., has been appointed Research Officer (In-charge of Furnaces), Central Glass and Ceramic Research Institute.

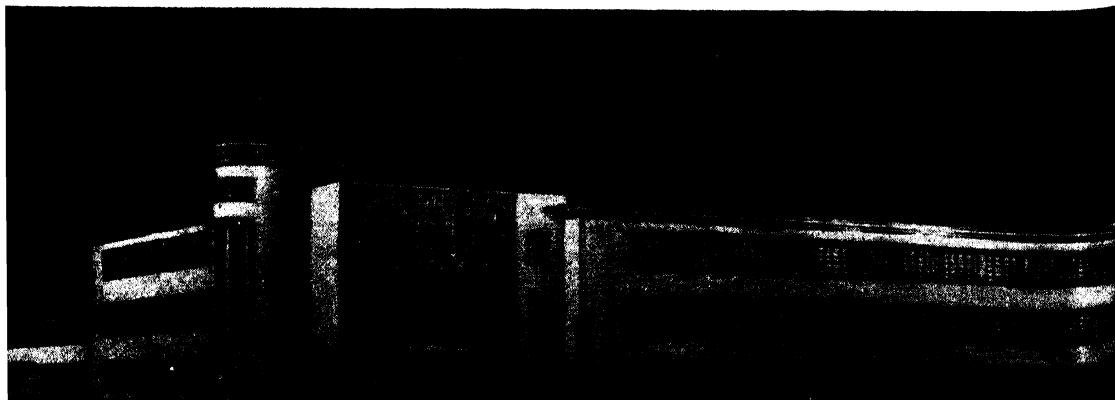
Central Advisory Board of Education.—The Governor-General-in-Council has been pleased to nominate the Hon'ble Dr. B. R. Ambedkar, Member of the Viceroy's Executive Council, and Rajkumari Amrit Kaur as members of the Central Advisory Board of Education in India for a period of three years with effect from 18th August 1945.

Associateship in Sugar Technology.—The following candidates are declared to have passed the final examination of the Associateship Course in Sugar Technology held in June, 1945 :—

Madhukar M. Champarkerkar ; Panachand D. Jhaveri ; Chimanbhai I. Amin ; Raghunath P. Chitale ; Sunil Kumar Ghosh ; S. M. Azizul Bari and Vasudeo M. Gadgil.

CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE (*Perspective View*)

struction of the technological block of the Glass and Ceramic Research Institute at Jadavpore, Calcutta, is progressing rapidly.



Reports from States and Provinces

Madras

THE Government of Madras have under consideration the opening of a shark fishery at Point Calimere, and to construct boat-making and net-making yards at Adirampatnam. The idea is to send, in the first instance, the crude shark liver oil obtained from the shark fishery at Point Calimere with local labour and as a cottage industry, to the Government Oil Factory at Calicut for refinement. Later, when machinery becomes available, a first class oil refinery would be built and run by the Government at Point Calimere itself.

The opening of boat-building and net-making yards at Adirampatnam was with a view to encouraging the fisher-folk of the village in deep sea fishing operations. Except a small fish hatchery in the Blue Mountains, there are no hatcheries in India as in America and Japan, and the agricultural associations in the Province should strive to establish at least one hatchery for each revenue village on a co-operative basis.

Mysore

Scope for the Formulation of Regional Planning Scheme in Mysore

Mr. B. S. Narayana Rao, Engineer, Messrs. L. S. Bedi & Sons, Bangalore, writes:—

The river basins of Sharavati and Thungabhadra in Mysore State, seem to have many favourable factors for the formulation of regional planning schemes on the lines of T.V.A. of the United States of America. The Sharavati basin, though small in length (when compared to the natural length of the river basins of Thungabhadra and Cauvery which have a length exceeding 600 miles within the State limits), its direction of flow to the west in the midst of deep gorges in the Western Ghats, places this river at a high "economic potential" so far as the development of hydro-electric energy is concerned. Power being the fundamental requisite for the establishment of industries, and the Western Ghats area being rich in forests and minerals, large-scale industries like the manufacture of heavy chemicals, rayon, pulp and paper and aluminium, could be taken up very conveniently in this region. As the river flows very near Bhatkal, the proposed harbour point for the State, a scheme to divert the wastes of this river through this point would not only provide a means of inland communication in the hinterland of the harbour but enhances the harbour facilities as well.

The Thungabhadra Valley in Mysore bears much resemblance to the Tennessee Valley in America. A multi-purpose project in this valley, like the inter-connecting of the river basin of this river with those of the rivers flowing at the centre of the State like the Hemavati, Yegachi, Shimsha and Vedvati, could easily solve many economic problems in the State of Mysore.

Bihar

A Note on Mica Mining (1880-1945)

The period of 30 years, from 1880 to 1910, may be called the infancy of mica mining in Bihar. Before that period, small quantities of mica were being mined in a primitive fashion by the natives of Chota Nagpur. These pits or fox-holes were called *mahajani khads* or *labana naths*. When primitive mica mining began, cannot be ascertained; but we learn from Roman History that in the second century B.C., Indian talc or mica was being used to decorate houses in Italy. In the Indian *Ayurveda*, preparations of medicines from *Avra*, i.e., mica were prevalent about 1000 B.C.

In about the year 1880, the late F.F. Chrestien and the late Babu Raj Krishna Sahana, the two pioneers of mica mining, started mining operations in Tisri and Kodarma respectively. The late Babu Dhir Gopal Lall started mining work in his own property in Saphi and Belam in the district of Gaya adjoining Hazaribagh, about that time. Others followed, notable amongst them being the late Babu Monoranjan Guha Thakurta, S. N. Tagore, B. N. Gupta, Mr. McDonald of the *Bengal Mica Syndicate* and Mr. Clyburn of Messrs. *Gladstone Wyllie & Co.*

During this period, there was no railroad to Kodarma; the nearest railway station was Giridih, from where people travelled in *Push-Push* (a hand-drawn palanquin-cart) or in bullock carts. The road from Giridih to Kodarma (65 miles) was infested with wild animals and highway robbers. The Kodarma Reserve Forest was at that time full of Bengal Royal tigers, leopards and bears. Life of the prospectors for mica in those days was extremely difficult and perilous.

Before the year 1903, all the mica mines were settled on annual rent and were annually auctioned by the Deputy Commissioner of Hazaribagh. Each mine was separately demarcated. They were called *khutua khuds* as *khuta* or pillars were put on four sides of the mine. Rents were paid to the Forest Department. A theodolite survey of the Kodarma Reserve Forest was carried out by the Government in 1903 and the whole area was divided into squares of 40 acres, and settled for a period of 30 years. The rent fixed was Rs. 1-8 per acre.

In 1908, the Grand Chord Line was opened and Kodarma was linked up by rail with the rest of India. Prices of mica were low. No machinery was used for mining and the tools employed consisted of chisels and hammers. Either earthen pitchers or buckets were used to dewater the pits; gun-powder was used for blasting rocks. Dynamite was first introduced in about the year 1905. The *Kodarma Mica Mining Association*, consisting of the principal interests in mica, was formed in March 1907.

During the following period 1910 to 1920, the most notable world event was World War I. The Government purchased only good quality mica for war purposes. In 1919, the first steam boiler was introduced in mica mining. Mechanization of mines has since grown both in volume and in diversity. Various kinds of machinery such as air compressors,

rock-drills, hoists, pumps, etc., have since been employed. There were about 10 or 12 mica exporters and dealers during this period.

The period 1920 to 1945 has seen great changes in the mica industry. The prices of mica were higher during the period 1921-29 than in the previous years. With the rise in commodity prices, mica theft increased to such proportions that every thoughtful man who looked upon the mica industry as a national asset became greatly perplexed. An agitation was started by the mine operators for the promulgation of a special law to check mica theft, as the ordinary laws of the land were inadequate to cope with the crime. In 1929, a Select Committee presided over by Mr. Witty, visited Kodarma and the *Mica Act* of 1930 was passed into law by the Bihar Government. The *Act* was, however, repealed by the Bihar Legislature in 1939.

The mica industry passed through one of the worst slumps for about six years from 1930 to 1936. From 1937 to 1939, there was a good demand for mica, probably because the nations were preparing for World War II which started in September 1939. Representatives of the mica industry were called to a conference at Delhi in 1940 by the Supply Department of the Government of India; the Geological Survey of India started buying mica in the latter part of 1940 and this arrangement continued until August 1942, when the Joint Anglo-American Mica Mission stepped in to purchase the mica.

The *Mica Act* of 1930 was again passed into law, with minor modifications, by the promulgation of the *Mica Control Order* of 1940. It was considered essential by both the Provincial and Central Governments to prevent mica from falling into the hands of the enemy and to check mica piracy.

A *Central Mica Inquiry Committee* was appointed in the latter part of 1944, with the Hon'ble Justice Reuben as Chairman, to inquire into the condition of the mica industry and to make suitable recommendations. This Committee is expected to submit its report within this year, i.e., within 1945.

Mica mining is now a fully developed and mechanized mining industry. The deepest mine in the Kodarma Reserve Forest is only about 600' in vertical depth. It is almost certain that the mica mines will be worked to still greater depths in years to come. Although mica mining has become predominantly a mechanized industry, requisite machinery is scarcely available; the cost of production of mica has greatly increased during recent years. The Joint Mica Mission and the Geological Survey of India have supplied some machinery to the industry but it is totally inadequate to meet the requirements. In the war, that has now concluded, the industry has tried its utmost to help the war effort of the United Nations by producing and supplying the maximum quantity of the precious material.

There are about 150 miner licensees, i.e., those who are allowed to mine mica in leasehold properties, in Bihar. Out of them 12 licensees produce among themselves as much as 80 to 90 per cent. of the total output. There are about 50 proprietor certificate holders, i.e., those who work in their own properties. There are 600 mica dealers and 500,000 labourers (including home splitters) and their dependents, working in the mica mines and mica factories of Bihar.

S. K. SAHANA

Ceylon

COLOMBO, 1st September 1945.

The Hon'ble Mr. S. W. R. D. Bandaranaike, Acting Leader of the State Council, sponsored his first Budget in July. Post-war planning was the keynote, and a National Development Reserve Fund of Rs. 110 millions at the end of 1944-45 has been suggested. New taxation proposals, which are calculated to bring in a revenue of Rs. 30 millions, will raise the National Reserve Fund to Rs. 140 millions at the end of 1945-46.

The Hydro-Electric Scheme which was launched before the war, and which is to constitute the backbone of the island's future industrial development, is to be soon resumed after its prosecution had been suspended for the past four years. Of the 8,000' of tunnelling to be done, 80 per cent. has been completed. While previous to January this year, only 70 tons of cement were used, since January, 250 tons are being used monthly to expedite the work. The Civil Engineering work which was previously done by the *Hindustan Construction Co., Ltd., Bombay*, is now resumed under the auspices of the Public Works Department. With regard to cables, turbines and engines, the contractors in the U. K. have informed the Ceylon Government that the prices of these have gone up by 90 per cent. They have, therefore, asked for a revision of the rates. The Board of Ministers is understood to be anxious to have the project completed as early as possible without permitting considerations of finance to block the way. The first part of the project is to be completed in three years, and will generate 25,000 k.w. The present output of the Colombo thermal stations is only 9,000 k.w.

A Cement Expert from England, Mr. R. E. P. Shearer, has arrived to study local conditions and report on the Ceylon Government's Rs. 8½ million cement project. The site of the proposed cement factory is Jaffna, where there are huge and excellent limestone deposits. High cost of imported coal and the high cost of transport will increase the manufacturing costs of the cement. The requirements of the island for cement appear to be comparatively small. The State Council has considered all the implications and has voted Rs. 50,000 towards the preliminary expenses of the survey.

The two glass factories in the island, one owned by the Government and the other by a private enterprise and started during the war, have not come up to expectations so far as the quantity of output is concerned. This created a problem for the Controller of Imports quite recently, as he expressed regret for not having issued enough import licences to meet the bare needs of the country in glassware, particularly tumblers. He had been misguided by exaggerated figures of local production capacity.

The Tea Research Institute's "Tablet Tea" scheme, making short work of tea manufacture in the estates, was subjected to discussion at a meeting of the planters held recently. The question was asked whether up-country tea retained its distinctive flavour under the new process, or whether all teas were reduced to a common proletarian level. In reply it was stated that according to J. Lamb, Biochemist of the *Tea Research Institute*, the flavour of different teas would not be changed. Tablet tea had been brewed and tasted, and found to be "very good," except that it seemed a bit "raw."

S. R. K. M.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for August, 1945. Patents from the *Council of Scientific and Industrial Research* are indicated by an asterisk.*]

30666. HEAT EXCHANGE DEVICES: *Sealing sheet being threaded through space between adjoining envelopes having ends folded over flanged portions.*—I.C.I. Ltd.
31157. GAS PRODUCERS: *Two separate fire zones in a single bed of fuel, and with means for supplying air thereto.*—Waugh.
31165. POLARITY REVERSING ELECTRIC DISTRIBUTORS FOR INTERNAL COMBUSTION ENGINES: *Reversing polarity of breaker points at each operation.*—Ford Motor Co. of Canada Ltd.
31171. WINCHES: *A power drive with forward and reverse gears between winch barrel and power member and clutches for bringing either gear into operation.*—Stormont Engineering Co., Ltd.
31240. TITANIUM OXIDE: *Heating Bauxite sludges with potassium hydrogen sulphite and recovering the oxide.*—The Delhi Cloth and General Mills Co., Ltd. and Mathur.
31617. COLOURED MASSES AND ARTICLES: *Incorporating with a molten nylon a dispersion of a pigment.*—I.C.I. Ltd.
31642. AZO DYESTUFFS: *Aminotoluene derivative is diazotised and coupled with o-anisidine, the product again diazotised and coupled with a pyrazolone derivative which in turn is again diazotised and coupled with a benzoyl derivative.*—E. I. Du Pont de Nemours and Co.
31677. IMPROVEMENTS IN OR RELATING TO MACHINE KNITTING NEEDLES: *One end of a tube flattened and its substantial portion removed, the remaining edge thereof bent to form a hook.*—F. N. F. Ltd.
31782. HYDROCYANIC ACID AND CATALYSTS THEREFOR: *Passing a mixture of nitric oxide and hydrocarbon over platinum containing catalyst.*—E. I. Du Pont de Nemours and Co.
31864. SHAPED ARTICLES FROM SYNTHETIC LINEAR POLYAMIDES: *Shaping a gel comprising a polyamide and an organic solvent and then removing the solvent.*—E. I. Du Pont de Nemours & Co.
31902. NEW SULPHANILAMIDE DERIVATIVES: *Interacting 2-amino-4: 6-dialkoxy-pyrimidines with p-acylamino or nitrobenzene sulphonyl halide.*—I.C.I. Ltd.
31935. BUILDING CONSTRUCTIONS: *Hollow bricks having vertically aligned recesses at top and bottom edges and loose blocks in said recesses.*—Deeley.
31939. RADIO NAVIGATIONAL APPARATUS: *Indicating means for altitude and direction of course of airplanes, consisting of a combined localiser and marker beacon system using radio signals.*—Standard Telephones and Cables Ltd.
32236. PLOUGHS: *Provided with a share having two cutting edges to share the soil along two planes.*—Edmonds.
- *32237. EXPULSION OF THE SHELL LIQUID FROM BHILAWAN OR CASHEW NUTS: *Exposing the nuts in a closed vessel to superheated steam at temperatures from 150°—300° C.*—Siddiqui and Khan.
32249. PERSIAN WATER WHEELS: *Adjustment of load within capacity of operating power unit, irrespective of water level, by semi-automatic control of springs which stretch and change the side tilt of buckets.*—Edmonds.
32255. ELECTRIC FUSE WELDER: *Comprising clamping means for conductors and welding electrodes with means for advancing them into contact with conductor ends.*—Standard Telephones and Cables Ltd.
32291. HYDRAULIC PRESSES: *Pressure element arranged at one side and fluid pressure counterpoise at other side of the tie bar, both between two beams. Affords accessibility to moulds, dies and the like.*—Coventry Machine Tool Works Ltd. and Higginson.
32296. METALLISATION OF NON-CONDUCTIVE FABRICS AND FIBROUS OR POROUS MATERIALS: *Material is first rendered electrically conductive then non-conductive, after that subjected to electro-deposition.*—Callender-Suchy Developments Ltd. and Suchy.
32325. METERING TYPES OF DISPENSING APPARATUS: *Hollow flow indicator embedded in the stopper of the container.*—Schering & Glatz, Inc.
32349. BUILD-UP CRANKSHAFTS: *Coaxial hollow portions of crank pin secured against internal flange of encircling sleeve having external bearing surface.*—Alvis Ltd.
32401. COPPER BASE ALLOY: *Containing tellurium, nickel, silver and oxygen for contact welding electrode.*—Enfield Rolling Mills Ltd. and Sykes.
32412. HYDRAULIC CLUTCH OR COUPLING: *Transmission of torque due to rise in fluid pressure Damping torsional oscillation.*—Hindmarch.
26979. TAPPING MOLTEN METAL FROM A FURNACE OR OTHER PLANT: *Placing a raft into the slag near the surface of the metal at the place when a funnel would normally be formed.*—Societe D'Electro-Chimie, D'Electro-Metallurgie et Des Acieries Electriques D'Ugine.
29536. CONTROL OF INTERNAL COMBUSTION ENGINES: *Pressure-sensitive capsule, moving valve which controls XXX boost servo motor, ported member and means for moving ported member.*—D. Napier & Son Ltd.
31224. FERTILIZERS: *Containing ammonium nitrate and a powdered hygroscopic substance.*—I.C.I. Ltd.
31276. A CLUTCH DEVICE: *Power is transmitted through planetary pinions operating an internally cogged drum.*—Krishnanath Balkrishna & Co.

31297. BUILDING CONSTRUCTION: *Roof comprising a sheet of building board stressed to form a right circular cone.*—Masonite Corporation.
31306. SPEED CONTROL GEAR OF PRIME MOVERS: *Device for altering speed-response of governor, regulating means, and remote control for regulating means.*—Blackstone & Co., Ltd.
31316. HAND-OPERATED PUMPS: *Piston with axial passages and clock valve.*—The Pyrene Co., Ltd.
31317. HAND-OPERATED PUMPS: *Piston with axial passages, clock valve and escape path for liquid.*—The Pyrene Co., Ltd.
31515. MELAMINE: *Heating urea and/or ammonium cyanate and/or guanyleurea and/or thermal decomposition products of said substances in presence of ammonia.*—American Cyanamid Co.
31527. INJECTORS FOR CHARCOAL GAS PLANTS: *Walls are scalloped to yield to expansion and construction of the metal.*—Jamshedpur Eng. and Machine Mfg. Co., Ltd.
31738. ELECTRICAL SYSTEM FOR SIMULTANEOUS OPERATION OF PLURALITY OF ELECTRIC MOTORS: *Connections so arranged so that supply of current to rotor windings cause rotors to move to predetermined positions with respect to stator either before starting and stopping.*—Electrolux Corpn.
- *31877. FLUX COMPOSITIONS FOR ALUMINIUM OR ITS ALLOYS: *Composition having a fusible base like borax and sulphite or bisulphite.*—Bhatnagar and Sundara Rao.
31893. COUPLER OPERATING ROTOR: *Comprising a number of pivotally interconnected members.*—American Steel Foundries.
31970. SIGNALLING APPARATUS PARTICULARLY* FOR USE IN CONNECTION WITH KITES OR BALLOONS: *Signalling apparatus with twin flex conductors used as leads for lamp signalling and as aerial for radio communication.*—International Marine Radio Co., Ltd.
31996. ELECTRICAL SWITCHGEAR AND PROTECTIVE DEVICES: *A protective device for electric circuits comprising a circuit-breaker in series with a fusible cut-out.*—Cantie Switches Ltd.
32068. ELECTRICAL FUSES: *With detachable portion interlocked with fixed portion by bayonet catch lock.*—Carlisle Electrical Mfg. Co., Ltd.
32079. FLUSHING CISTERNS: *Plug controlling the opening of outlet pipe is supported in raised position by supporting elements.*—Khanna.
32088. MOVING COIL LOUDSPEAKERS AND MICROPHONES: *Electro-acoustic apparatus wherein the coil-carrying diaphragm and the flexible diaphragm enclose the magnet system.*—The Mullard Radio Valve Co., Ltd.
32105. WELDING EYE GLASSES: *Wherein infra-red ray is filtered by a transparent mirrored surface and ultra-violet and visible rays filtered by coloured lamina.*—Morgan and Henderson.
32138. COMBINED RADIO TRANSMITTER AND LOUD SPEAKER INSTALLATION: *With a common low frequency amplifier.*—International Marine Radio Co., Ltd.
32223. DYE FROM TAMARIND SEED TESTA: *Treating aqueous extract of seed testa with acid.*—Sri Krishna.
32278. BRACELETS OR CHAINS FOR WATCHES: *A series of frames, a spring piece within each frame, a sheath and connectors.*—Sheth.
32280. A TOY GUN: *Comprising barrel mounted on a carriage, and elastic band secured in such a way as to project the dummy shell on releasing the pulled elastic band.*—Sait.
32321. SHEARS: *Blade of shear provided with spaced elements consisting of rolling members engaged in grooves placed around the pivot.*—Wilson.
32380. LINING ACID BESSEMER CONVERTORS: *Under-fired silica bricks used for lining acid Bessemer convertor.*—Mitra.
32385. WIRE BRUSHES: *Embedding looped end of each tuft or bunch of bristles in holes of a wooden plate by a pin.*—Jain.
32398. EXTRUSION MACHINES FOR NON-METALLIC PLASTIC MATERIALS: *A number of pairs of dies, axial feed passage, branch passages and extrusion chambers.*—St. Helens Cable & Rubber Co., Ltd.
32420. CHLORINATING APPARATUS: *Means to control level of drip tube, discharging solution from equalizing vessel, receiving solution from main tank.*—Bell and Childs.
31302. SULPHUR-CONTAINING DYESTUFFS: *Heating phthalocyanine sulphonyl chloride with a mercaptan derivative.*—I.C.I. Ltd.
31303. SULPHUR-CONTAINING DYESTUFFS: *Heating a metal or metal-free phthalocyanine sulphonyl chloride with a thioamide.*—I.C.I. Ltd.
31304. NEW ANTHRAQUINONE DYESTUFFS: *Introducing into the anthraquinone molecule, two alkane—or phenylalkane sulphonylbenzoylamino groups.*—I.C.I. Ltd.
31383. CONTAINERS FOR LIQUIDS: *Tailored fabric of desired shape impregnated with synthetic plastic or rubber-like substance.*—I.C.I. Ltd.
31468. FOUNTAIN PENS: *Provided with ink chamber within the barrel.*—Dalal.
31735. PEST CONTROL COMPOSITIONS: *Containing a compound having general formula as $R_1R_2CH-CX_3$ where X represents halogen and R_1 and R_2 organic radicals.*—I.C.I. Ltd.
31789. ELECTRIC TUMBLER SWITCHES PARTICULARLY FOR ALTERNATING CURRENT CIRCUITS: *Moving contact plate rests on a pair of fulcra, small gap between this and fixed contact in enlarged for isolation when plate rests on only one fulcrum.*—Crabtree & Co., Ltd.
31819. ADIPIC ACID: *Continuously introducing cyclohexanol and nitric acid solution into a reaction vessel.*—I.C.I. Ltd.
31883. FRAMES FOR SPECTACLES, SUN-GLASSES OR THE LIKE OPTICAL GOODS: *Dipping horn in acid, pressing, cutting parts of the frame and joining.*—Gupta.
31906. PRESSES OR THE LIKE: *Pair of interconnected mould sections.*—Dunlop Rubber Co., Ltd.
31961. COOKERS: *Producing steam by putting circulating water pipe in furnace.*—R. Dass and S. Bannerji.
31973. MANUFACTURE OF NITRO SULPHONIC ACIDS: *By a reaction between nitro-olefine and a soluble sulphite or bisulphite.*—I.C.I. Ltd.
- *32352. RUBBER FROM CRYPTOSTEGIA: *Softening twigs of cryptostegia, grinding into pulp and stirring with water.*—Bhatnagar, Karimullah and Shankar.
32438. A PARASITICIDE: *D. D. T. powder dissolved in spirit or any organic solvent and mixed in fixed oils.*—Schroff.
32473. SEPARATING MILKWEED AND/OR KAPOK PODS INTO THEIR SEPARATE COMPONENTS: *Crushing pods by a pair of rollers without breaking the shell halves, feeding the crushed pods to a rotatable separator to remove seeds and pod-shells.*—Milkweed Products Development Corpn.
32955. SELF-INKING WRITING APPLIANCES: *Nibs coated with ink composition.*—Dalal.

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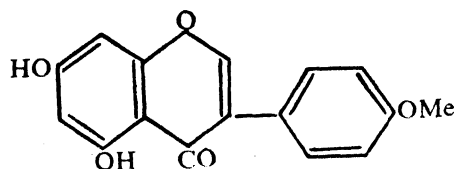
STUDIES IN THE CONSTITUENTS OF *CHANA* (*CICER ARIETINUM* LINN)

PART II.—THE CONSTITUTION OF BIOCHANIN A

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THE preceding communication of the series¹ reported the isolation of three crystalline constituents, namely, biochanin A ($C_{15}H_9O_4(OMe)$; m. p. $212^\circ C.$), biochanin B ($C_{15}H_{12}O_4$; m. p. $250^\circ C.$), and biochanin C ($C_6H_{13}O_4N_3$; m. p. $310^\circ C.$ decomp.), and gave a general description of their chemical and physical characteristics. The present paper embodies the results of subsequent investigations on the constitution of the principal crystalline product, biochanin A, which were principally based on a close study of its colour reactions and the action of alkali and permanganate under varying conditions of temperature, concentration and duration of reaction. As a result of these investigations and a further extension of the molecular formula of biochanin A to $C_{15}H_7O_2(OH)_2(OMe)$, through acetylation and methylation, the following constitution has been tentatively arrived at for biochanin A:—



As stated in Part I, biochanin A dissolves in dilute alkali giving a bright yellow solution, in concentrated sulphuric acid giving a yellow solution and in concentrated nitric acid forming reddish brown to light red solutions according to the concentration of the substance. In the ferric chloride-alcohol

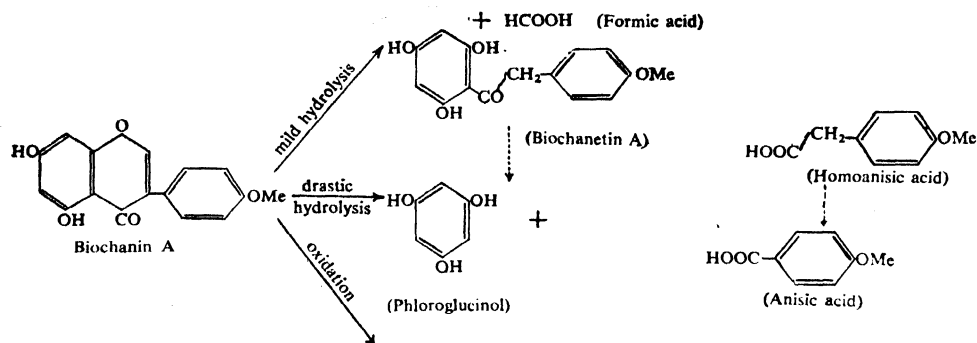
test it gave a deep violet coloration. It has further been noted now that an alcoholic solution of biochanin A does not produce any pink or red colour with concentrated hydrochloric acid and magnesium. Sodium amalgam reductions in alcohol followed by acidification and dilution with water, however, give pink to orange precipitates with biochanin A, the depth of the colour depending on the time allowed for the reduction.

Asahina and co-workers² have shown that flavones are reducible by sodium amalgam and not by magnesium and hydrochloric acid, whereas flavanols unsubstituted in position 3 are reducible by magnesium and hydrochloric acid but not by sodium amalgam. Flavanones and flavanols substituted in position 3 by a methoxy or a sugar residue are reducible by both the methods. All these reduction products are of a flavylum salt nature which give pink to red coloration or precipitate in an acidic medium. The same reduction colour tests have since been found by Wolfrom and co-workers³ to be applicable in the case of isoflavones and isoflavanones. The positive reduction colour test for biochanin A as noted above, therefore, indicated a flavone or an isoflavone structure for it.

The isoflavone structure was first postulated by Finckmore⁴ in the case of genistein (prunetol) and established by Baker and Robinson⁵ through synthesis. An isoflavone is characterized by the fact that mild alkaline hydrolysis produces formic acid and a *o*-hydroxy phenyl benzyl ketone which on

further treatment with strong alkali breaks up into a phenol and a phenyl acetic acid⁶. In the case of biochanin A mild alkaline hydrolysis produced formic acid and a trihydroxy phenyl 4'-methoxy benzyl ketone. This ketone was characterized through the oxime and named biochanetin A, in conformity with the usual nomenclature. Biochanetin A gave a characteristic dark reddish violet coloration with alcohol-ferric chloride. More vigorous alkaline treatment of biochanin A yielded homoanistic

hydroxyl group in natural flavones and isoflavones, it appeared probable that the two hydroxyl groups were present in *m* position 5, 7. This view was further substantiated by the fact that biochanin A was found to have no reducing action on alkaline *o*-dinitrobenzene⁷ or chloropentamine cobalt chloride⁸, and an *o*- or *p*- configuration of the two hydroxyl groups was, therefore, excluded. Ultimately, the position of the two hydroxyl groups was established by the actual isolation of phloroglucinol under a



acid (*p*-methoxy phenyl acetic acid). Direct evidence of the formation of homoanistic acid as a result of further degradation of biochanetin A could not be provided at present for lack of sufficient material. The fact, however, that both biochanin A and homoanistic acid have been isolated from a mild hydrolysis of biochanin A in complementary proportions should constitute sufficient indirect evidence as to the course of hydrolytic degradation of biochanin A indicated in the table on page 233. The technique of alkaline treatment of biochanin A under varying conditions closely followed that employed by Walz⁶ in his studies on the isoflavones, daidzein and genistein.

Alkaline or neutral permanganate oxidation of biochanin A also produced anisic acid which is evidently a further degradation product of the homoanistic acid part of the molecule.

The position of the two phenolic groups remained to be fixed. On treatment with methyl iodide in the presence of potassium carbonate, biochanin A gives a monomethyl ether which imparts a dark reddish violet colour to alcohol-ferric chloride. These observations led to the conclusion that one of the phenolic groups is present in position 5 which usually resists methylation on account of its being strongly chelated. As in most cases position 7 is the first preference of the

certain procedure of hydrolysis of biochanin A described in the experimental.

The constitution arrived at for biochanin A as a 5, 7 dihydroxy 4'-methoxy isoflavone places it as 4'-methyl ether of genistein. Biochanin A was demethylated and the acetyl derivative of the demethylation product was prepared. These derivatives were not sufficient in quantity for analysis, but their melting points were compared with those recorded for genistein and acetyl genistein. Demethyl biochanin A showed m.p. 297-98° C., darkening earlier, which is in complete agreement with the m.p. recorded for genistein, 296-98° C. (290° C.-brownish). The ferric chloride-alcohol coloration is also the same, deep reddish violet, in both the cases. Acetyl demethyl biochanin A showed the m.p. 198-99° C. as against 200-202° C. recorded by Walz for acetyl genistein.

Walz has prepared one monomethyl and two dimethyl ethers of genistein. The monomethyl ether has been described by him as 4'-methyl ether with a ? mark. The ferric chloride-alcohol test of biochanin A agrees with the colour reaction noted for the 4' (?) methyl ether of genistein, but the m.p. of this product has been recorded by him as 189-91° C. which is 21° C. lower than that noted for biochanin A (212° C.). This is apparently due to the fact that the mono-

methyl ether of Walz either did not have the methoxyl group in position 4' or was a mixture of isomeric, presumably 4' and 7 monomethyl derivatives of genistein. Biochanin A monomethyl ether melts as 139—40° C. and gives a dark red colour with a violet tinge in the ferric chloride-alcohol test. 7, 4' dimethyl genistein of Walz, which should be identical with the 7-methyl ether of biochanin A, is also recorded to melt at 139—40° C. and gives a dark red colour with alcohol-ferric chloride. Thus, though direct comparison of demethyl biochanin A with genistein was not possible on account of the non-availability of an authentic sample of the latter, a reference to the melting points and ferric chloride-alcohol colour reactions of the two sets of compounds, as summarized below, serves to confirm the constitution of biochanin A, arrived at by the present authors through degradative methods.

	Genistein (Walz)	Demethyl Biochanin A
	Yellow prisms, m.p. 296-98° C. (darkening at 290° C.); FeCl ₃ -alcohol, deep reddish violet colour.	Yellow prisms, m.p. 297-98° C. (darkening earlier); FeCl ₃ -alcohol, deep reddish violet colour.
Acetyl derivative	m.p. 200-202° C.	Colourless needles, m.p. 198-99° C.
Monomethyl derivative	4' ? methyl ether, m.p. 189-91° C.; FeCl ₃ -alcohol, red violet colour.	Biochanin A, m.p. 212° C.; FeCl ₃ -alcohol, deep reddish violet colour.
Dimethyl derivative	7, 4' dimethyl derivative, m.p. 139-40° C.; FeCl ₃ -alcohol, deep red colour.	7-methyl ether of Biochanin A, m.p. 139-40° C.; FeCl ₃ -alcohol, deep red colour with violet tinge.

To our knowledge, biochanin A is the first non-glucosidic isoflavone isolated from a plant body the constitution of which has been established. As only neutral solvents were employed under the mildest condition in the process of isolation of the substance from the *chana* germ, it may be concluded that the isoflavone occurs in the germ in the free state. In this connection reference may be made to the other two non-glucosidic isoflavones, osajin³ and pomiferin⁹ isolated from Osage orange, *Maclura Pomifera* Raf., for which tentative structures containing an unidentified C₁₀H₁₅O residue have been suggested, which, in obvious contrast to biochanin A, however, will not in any case represent the simple isoflavone molecule. The method of isolation of the two non-glucosidic isoflavones, tatin and methyl genistein¹⁰ from soybeans (*Soja hispida*), leaves doubt as to the occurrence of these two isoflavones in the free state in the plant body.

It is striking to note that though the flavones have been found to occur abundantly in nature, isoflavones have been isolated from plant material only in a few instances. In view of the fact that, as communicated in the preceding paper, biochanin A has been observed to deteriorate when the *chana* germ is dried under ordinary conditions, probably as a result of enzymic action, it would appear that isoflavones are particularly susceptible to enzymic degradation and that further investigation with the precautions observed in the present case will result in the isolation of many more members of the isoflavone series. Investigations directed towards further clarification of this point are in progress and the result will be communicated in a subsequent paper. The final confirmation of the constitution of biochanin A by synthesis is also in progress.

Experimental

Further Characterization of Biochanin A ; Colour Tests.—Biochanin A gave a yellow

coloration on the addition of a few drops of conc. sulphuric acid to a glacial acetic acid solution of the substance. Similar colour reaction is also given by the other known isoflavones. No coloration was produced by reduction with magnesium and hydrochloric acid. The reduction with sodium amalgam was carried out in the following way: about 10 mg. of the substance was dissolved in 3 cc. of 95 per cent. ethanol, and 3 per cent. sodium amalgam was added in small quantities. After allowing the stoppered solution to stand for some time, a portion was decanted from the sodium amalgam and acidified with an excess of hydrochloric acid. A pink solution was produced which gave a pink precipitate on dilution with water. It was found that if the solution was allowed to stand for a longer period, the colour of the precipitate obtained was darker in hue.

Acetyl Biochanin A.—Biochanin A (0.1 gm.) was heated on the water bath for one hour with freshly fused sodium acetate

(1 gm.) and acetic anhydride (2 cc.). After cooling, the reaction mixture was poured into ice water. The solid which separated out was collected and crystallized from alcohol-water and acetone when acetyl biochanin A separated out in colourless silky needles, m.p. 190° C., yield 0.1 gm. The acetyl derivative did not give any coloration with ferric chloride-alcohol. (Found: C, 65.08; H, 4.48; $C_{20}H_{16}O_7$ requires C, 65.22; H, 4.35).

Monomethyl biochanin A.—Biochanin A, (0.15 gm.) was refluxed on a water bath with freshly heated potassium carbonate (0.3 gm.), anhydrous acetone (2 cc.) and methyl iodide (1 cc.) for two hours. The reaction mixture was left at the ordinary temperature overnight. After removing methyl iodide and acetone on the water bath, cold water was added to the mixture, when the monomethyl derivative separated out. It crystallized from alcohol-ethyl acetate mixture in colourless rectangular plates and rods, yield, 0.1 gm., m.p. 139–40° C. It gave a deep red colour with a violet tinge with ferric chloride-alcohol. (Found: C, 67.53; H, 4.60; OMe, 21.45; $C_{17}H_{14}O_5$ requires C, 68.45; H, 4.70; OMe, 20.81).

Hydrolysis of Biochanin A to Biochanetin A and Formic Acid.—Biochanin A (0.5 gm.) was dissolved in hot absolute alcohol (5 cc.) and added to a hot solution of sodium hydroxide (prepared by dissolving 3 gm. of sodium hydroxide in 15 cc. of water and 5 cc. of alcohol). The solution was kept at the boiling point for 15 minutes, cooled and just acidified with dilute phosphoric acid, and then extracted with petrol ether (four 75 cc. portions). On removal of the solvent from the petrol ether extract, the ketone was obtained in colourless prisms, which on recrystallization from ether, petrol ether and dilute alcohol, melted at 160° C., and gave dark reddish violet coloration with ferric chloride-alcohol. Yield 0.2 gm. (Found: C, 65.45, H, 5.65; $C_{15}H_{14}O_5$ requires C, 65.70, H, 5.11.)

The aqueous layer in the above working of the products of hydrolysis was steam distilled. The distillate gave a positive test for formic acid when subjected to formaldehyde-milk test, which was carried out as follows:—A 2 cc. portion of the distillate was reduced with magnesium and hydrochloric acid and then 2 cc. of fresh milk added to it followed immediately by the careful addition of 0.5 c.c. of concentrated sulphuric acid along the side of the test tube.

An intense violet ring was obtained at the junction of the two liquids. Parallel experiments with distilled water and very dilute formic acid were made for comparison.

Homoanisic Acid from Biochanin A.—Biochanin A (0.5 gm.) was added to a hot 25 per cent. alcoholic potash solution (15 cc.) and refluxed for five hours. The solution was cooled, acidified with dilute sulphuric acid and extracted with ether. The oily residue left on removal of ether yielded a crystalline product from its ether-petrol ether solution which on repeated alternate crystallizations from water and ether-petrol ether, finally melted at 86° C. and showed no colour reaction with ferric chloride. Yield 0.2 gm. The acid thus obtained showed no depression in its melting point on admixture with an authentic sample of homoanisic acid, m.p. 86° C., prepared from benzyl cyanide through *p*-nitro, amino, hydroxy, methoxy derivatives and final hydrolysis of *p*-methoxy benzyl cyanide. The homoanisic acid obtained from biochanin A gave the following analytical result: Found: C, 64.50; H, 5.84; OMe, 18.66; $C_9H_{10}O_3$ requires C, 65.06, H, 6.02, OMe, 18.7.

Isolation of Phloroglucinol from Biochanin A.—Biochanin A (0.2 gm.) was dissolved in a hot solution of alcoholic sodium hydroxide (3 cc., 15 per cent.) and the solution was kept at the boiling point for thirty minutes, cooled, acidified with dilute sulphuric acid, made just alkaline with sodium bicarbonate and extracted with ether. After removing ether from the extract, the residue containing the phenolic fraction was repeatedly extracted with water. Biochanetin A was obtained from the water insoluble residue. The coloured aqueous extract was charcoaled and the solvent removed from the clear solution in a desiccator in vacuo. The residue thus obtained yielded a product on crystallization from ether-petrol ether, which melted at 218° C. and showed no depression in its melting point on admixture with Merck's phloroglucinol (m.p. 218° C.). The sodium bicarbonate solution on acidification with dilute sulphuric acid and extraction with ether gave crystals of homoanisic acid.

Oximation of Biochanetin A.—Biochanetin A (0.1 gm.) was dissolved in methanol (5 cc.) and refluxed on a water bath for about 5 hours with hydroxylamine hydrochloride (0.5 gm.) and freshly fused sodium acetate (1 gm.). The reaction mixture was cooled and poured into a large excess of ice and water (ca. 100 cc.). The precipitated

oxime was collected and crystallized from alcohol when it came out in nearly colourless, rectangular plates, which melted at 222-23° C. and gave a reddish violet colour with ferric chloride-alcohol. For lack of sufficient material, its analysis could not be carried out, but it was found to give positive test for nitrogen. The ketonic character of the product was further substantiated by the formation of a carbazone, which also gave the qualitative test for nitrogen but could not be sufficiently purified owing to lack of material.

Oxidation of Biochanin A to Anisic Acid.—Biochanin A (0.2 gm.) was dissolved in 1 per cent. potassium hydroxide solution (15 cc.), and a saturated solution of potassium permanganate added to it till the colour of permanganate persisted. The reaction mixture was then warmed on the water bath for some time and filtered. The residue was thoroughly washed with 1 per cent. caustic potash and the washings added to the filtrate. The combined filtrate was acidified with dil. sulphuric acid and extracted with ether. On removal of the solvent, the ethereal extract gave a crystalline product which on repeated crystallization from dilute alcohol finally yielded colourless, prismatic needles, m.p. 182° C., yield 0.07 gm. The acid thus obtained did not give any colour with ferric chloride and showed no depression in its melting point on admixture with *Merck's* pure anisic acid (m.p. 182° C.). Oxidation of biochanin A with neutral permanganate also gave the same product.

Demethylation of Biochanin A.—Biochanin A (0.2 gm.) was heated at 140° C. for two hours with hydroiodic acid (sp. gr. 1.7, 3 cc.) and acetic anhydride (5 cc.). The

reaction mixture was cooled and poured into about 50 cc. of water saturated with sodium bisulphite. The crystals which separated were collected, washed with water and recrystallized from alcohol and obtained in yellow prisms, m.p. 297-98° C. (darkening earlier), yield 0.12 gm. It gave a dark reddish violet colour with ferric chloride-alcohol.

Acetyl Derivative of Demethyl Biochanin A.—Demethyl biochanin A (0.05 gm.) was heated on a water bath for one hour with acetic anhydride (1 cc.) and freshly fused sodium acetate (0.5 gm.). The reaction mixture was poured into cold water and allowed to stand overnight. The acetyl derivative which separated out, crystallized from alcohol in colourless needles, did not give any colour with ferric chloride and melted at 198-99° C.

The authors are thankful to Mr. R. C. Tewari, micro-analyst, for the analytical data included in this communication.

References

- 1 Siddiqui, J. S. I. R., 1945, 3, 68.
- 2 Asahina and co-workers, *Ber.* 1928, 61 1646; 1929, 62, 3016; 1931, 64, 1256.
- 3 Wolfrom and co-workers, *J. Amer. Chem. Soc.*, 1940, 62 1484; 1941, 63, 1248.
- 4 Finnemore, *Pharm. J.*, 1910, 31, 604.
- 5 Baker and Robinson, *J. Chem. Soc.*, 1926, p. 2713; 1928, p. 3115.
- 6 Shibata, *J. Pharm. Soc. (Japan)*, 1927, 47, 380; *C. A.*, 1927, p. 3050; W. Baker, *J. Chem. Soc.*, 1928, p. 1022; Spath and Schmidt, *Monatsh.* 1929, 51, 454; Walz, *Ann.*, 1931, 489, 118.
- 7 Bose, *J. Indian Chem. Soc.*, Sir P. C. Ray 70th Birthday Vol., p. 65.
- 8 Shibata and Hattori, *Acta. Phytochim.*, 1930, 5, 117.
- 9 Wolfrom and co-workers, *J. Amer. Chem. Soc.*, 1941, 63, 1253.
- 10 Okano and Bepper, *Bull. Agri. Chem. (Japan)*, 1939, 15, 110.

PREPARATION OF ACTIVATED CHARCOAL (MEDICINAL)

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CARBON or charcoal is used in medicine internally as an adsorbent for gases and toxic substances in the alimentary tract, and externally as an antiseptic poultice to foul ulcers. It is also used for the decolorization of solutions for parenteral use. For all these purposes, carbon of a high degree of

purity and activity is essential. The present investigation was undertaken to prepare activated carbon for medicinal use from indigenous raw materials.

The starting materials chosen for these experiments were coconut shell and groundnut shell. Coconut shell charcoal is well

known for its gas adsorbing power since Dewar used it for the fractionation of liquid air. Rao and Rao¹ prepared charcoal from groundnut shell and stated that the product possessed good decolorizing power. In the present paper, the preparation of charcoal from the above sources has been described and their properties have been discussed with special reference to their suitability as medicinal charcoal.

The composition of the raw material would have a bearing on the character of the charcoal prepared from it. The composition of coconut shell has been studied by Child and Ramanathan² and that of groundnut husk by Bindal and Sreenivasaya³. Comparison of the figures show that while coconut shell contains only 0.61 per cent. of ash, the groundnut shell contains as much as 6.23 per cent. Potash constitutes the major constituent of the ash from coconut shells, while the ash from groundnut shells contains appreciable quantities of silica, potassium and calcium and a small proportion of phosphorus.

Carbonization.—The shells were powdered to pass through a 60-mesh sieve. A few samples were directly carbonized, without using any activating agent, but the degree of oxidation by air was varied by altering the time of carbonization in the furnace. In some cases, the powder was moistened with a saturated solution of zinc chloride containing 5 per cent. hydrochloric acid. Two samples of groundnut shell were digested with the acidulated zinc chloride solution and the pasty mass evaporated to dryness before carbonization. The shell appeared to dissolve in the solution during digestion. This procedure was, however, not applicable to coconut shell, which did not show any tendency to dissolve when treated in this manner.

The shell powder, whether treated or untreated, was taken in an alundum crucible closed with a fire-brick lid, and carbonized by heating in a coal-fired furnace of the crucible type. The time allowed for carbonization varied in the different cases from two to eight hours. The temperatures ranged from 600°-800° C. inside the furnace.

After carbonization, the charcoal was boiled with 10 per cent. hydrochloric acid and then washed by repeatedly boiling with distilled water, until the pH of the wash water was 6.0. At this stage it was free from chloride ions. The charcoal was finally dried at 200°-300° C.

Several tests were performed for determining the purity and adsorptive properties of the charcoal samples produced. Ash contents of the charcoals and their adsorptive powers for methylene blue and iodine were determined for most of the samples. These figures, together with the yields obtained from the raw shells, are given in Tables I and II. The adsorptive powers are expressed as mgms. of the substance adsorbed per gram of charcoal.

TABLE I. *Charcoal from Groundnut Shell.*

Sample No.	ZnCl ₂ used, %	Yield on raw shell %	Ash %	Adsorption of methylene blue mgm.	Adsorption of iodine mgm.
1	Nil	10.0	8.0	300	800
2	"	12.7	9.4	285	760
3	"	13.0	11.2	325	850
4	"	28.0	10.0		300
5	10	29.0		50	430
6	44	30.0	6.8	225	850
7	Digested	28.0	6.6	400	1,200
8	Digested	36.0	7.1	300	800

TABLE II. *Charcoal from Coconut Shell.*

Sample No.	ZnCl ₂ used, %	Yield on raw shell %	Ash %	Adsorption of methylene blue mgm.	Adsorption of iodine mgm.
1	Nil	12.5	4.5	200	870
2		30.0	3.5	20	290
3	15.5	24.3		233	944
4	45.4	30.0	0.72	218	1,020
5	50.0	16.0		350	1,150

The results in Tables I and II show that charcoal of good adsorbing power can be obtained from both groundnut and coconut shells. When no activating chemical is used, lower yields correspond to higher adsorbing powers.

When acidulated zinc chloride solution is mixed with shells before carbonization, the charcoal obtained has, for the same yield from the raw shell, a higher adsorbing power than that prepared without using the salt. The maximum adsorption is, however, observed in charcoal samples Nos. 7 and 8 obtained from groundnut shell, in the preparation of which the raw shell was digested with a saturated solution of zinc chloride containing hydrochloric acid.

The main difference between charcoal samples prepared from groundnut shell and coconut shell lies in their ash contents, the former leaving a higher percentage of ash on ignition. The use of acidulated zinc chloride has a definite effect in reducing the ash content of the charcoals, but this

effect is more marked in the case of coconut shell. With groundnut shell, the minimum ash content was 6.6 per cent. (sample No. 7) while charcoal sample 4 prepared from coconut shell has an ash content of only 0.72 per cent. The ash from charcoal samples Nos. 4 and 8 from groundnut shell, on analysis, gave the following results (Table III):—

TABLE III.

Sample No.	Ash content %	Fraction insoluble in HCl (mainly silica) %	Fraction soluble in HCl %
4	10.0	6.0	4.0 (contains Fe, Ca and phosphate)
8	7.1	6.56	0.54 (contains Fe and traces of Ca and phosphate)

Sample 4 was prepared without using zinc chloride and sample 8 by digesting with acidulated zinc chloride. The acidulated zinc chloride, therefore, appears to have removed the acid soluble portion of the mineral matter in the charcoals.

The soluble mineral matter contents of charcoals are reflected in the changes of pH and specific conductivities of water on shaking with the charcoal samples.

TABLE IV.

Charcoal sample	Change of pH of water		Change of sp. conductivity of water (mhos)		Acid soluble fraction %	Ash %
	Original	After treatment	Original			
Sample 6 (from groundnut shell)	6.25	6.00	4.56×10^{-6}	7.37×10^{-5}	0.81	6.8
Sample 4 (from coconut shell)	6.10	5.90	2.58×10^{-6}	2.98×10^{-5}	0.84	0.73

TABLE V. Charcoal from Groundnut Shell No. 7.

Particulars of test	Results	Remarks
Ash	6.6%	B.P.C. limit 7.0%
Moisture	4.5%	U.S.P. " 4.0%
Fraction soluble in dil. HCl	0.81%	" " 15.0%
Heavy metals	Nil	" " 3.5%
Uncarbonized matter	Nil	
Chloride	Nil	
Sulphate	Within U.S.P. limits	
Iron	B.P.C. "	
Cyanogen	Nil	
Absorption of methylene blue	400 mgm. per gm.	U.S.P. requires 125 mgm. per gm.
Absorption of water (maximum)	1.25 gm. per gm.	Ext. Pharm.—1.0 gm. per gm.
Absorption of iodine	1,200 mgm. per gm.	" 1,250 mgm. per gm.
Absorption of potassium permanganate	1,540 mgm. per gm.	" 500 mgm. per gm.
Absorption of mercuric chloride	530 mgm. per gm.	" 850 mgm. per gm.
Absorption of strychnine sulphate	Satisfies U.S.P. limits.	

ing with the charcoal samples. 1 gm. of the charcoal was shaken intermittently for 2 hours with 50 c.c. of distilled water and the pH and specific conductivities were determined both before and after treatment. The fractions soluble in hot dilute hydrochloric

acid were also determined. The results are given in Table IV.

The changes of pH and specific conductivity of water due to the soluble matter from charcoal are not very significant. Further, the changes produced by the two samples are of the same order, although they differ widely in their ash contents. The same is also true for their acid soluble fractions.

Charcoal 7 was subjected to all the tests for medicinal charcoal given in *U.S.P. XII* together with some of the tests given in the *B.P.C.* (1934) and the *Extra Pharmacopæia* (22nd edition). The results are given in Table V.

From the results of the tests given in the table, the sample tested seems to be suitable for medicinal use.

Summary

1. Activated charcoal has been prepared by carbonizing the shells of groundnut and coconut, with and without acidulated zinc chloride as the activating agent.

2. Charcoals from both these sources show good adsorptive power, and this is shown in a greater degree by the charcoals obtained by the use of acidulated zinc chloride.

3. Zinc chloride in hydrochloric acid solution serves to reduce the ash content by removing the acid soluble fraction of the mineral matter present.

4. A sample of charcoal obtained from groundnut shell by the zinc chloride process has been found to satisfy the various tests laid down for medicinal charcoal in *U.S.P. XII*, *B.P.C.*, and *Extra Pharmacopæia* (22nd Ed.).

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References

1. A. N. Rao and S. N. G. Rao, *J. Ind. Chem. Soc., Ind. and News Ed.*, 1939, 2, 161.
2. R. Child and S. Ramanathan, *J. Amer. Chem. Soc.*, 1938, 60, 1506.
3. A. N. Bindal and M. Sreenivasaya, *J. Sci. Ind. Res.*, 1944, 3, 247.

ANTI-CORROSIVE ACTION OF THE OXALIC ACID SERIES

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WAR-TIME shortage of mineral oil lubricants has led to detailed investigations on the suitability of vegetable oils, or blends of vegetable and mineral oil, for use as lubricants^{1, 2}. Blended oils corresponding to several grades of standard mineral oil lubricants have been prepared and are in use. The deterioration of vegetable oils due to oxidative changes, leading to bearing corrosion, presents a serious problem. The future of the vegetable oil lubricants will be determined by the success with which such deterioration can be checked and the safety of the bearings assured.

A large number of additives are recommended for restricting or inhibiting oxidation changes in vegetable oils. Such additives may be classified into three main groups:—Hydroxy compounds, e.g., phenolic derivatives, naphthols; nitrogen compounds of the type of naphthylamines and aniline derivatives; and certain halogen, sulphur and phosphorus compounds. These additives possess a twofold action on the lubricating oil and probably another distinct action on metal surfaces. In the first place they decrease oxidation rates or lengthen the induction period; secondly, they counteract the effect of metals which serve as accelerators of oxidation. The third action is the specific inhibition of metallic corrosion. Most additives show the first two actions to a varying degree, but relatively few are known to show the third one. The corrosion of the bearings is due not only to the free acids present in the lubricants, but also to the products resulting from the progressive oxidation of the oils. The corrosion effects of the products have been dealt with by Underwood³.

It has been found that the corrosion of metallic bearings is minimized to a remarkable degree by the addition of dibasic dicarboxylic acids. In the investigations reported in this paper, attention has been directed to their effectiveness as corrosion inhibitors.

Dibasic Acids as Antioxidants

In order to obtain a quantitative idea of the efficiency of these additives in inhibiting oxygen absorption, experiments were carried out with drying oils which absorb oxygen and gain in weight when exposed to air in thin layers. This technique has been employed in the study of the oxidation rate of drying oils^{4, 5}. Thin films of linseed oil, with and without additives, were spread over weighed watch glasses and exposed to air in a dust-free enclosure. The watch glasses were weighed at intervals to determine the increase in weight. In the initial stages there is a slight, but definite, loss in weight, as has been reported by previous investigators⁶. This is followed by an induction period during which there is hardly any increase in weight at all, and finally a period during which there is a continuous increase in weight due to oxygen absorption up to a maximum.

In Fig. 1, the percentage gain in weight of oils to which 0.1 per cent. oxalic acid and 0.1 per cent. α -naphthol are added, is plotted against time intervals in days. The results obtained without any additive are also plotted in the same figure. The addition of 0.1 per cent. oxalic acid extends the induction period to several weeks.

Inhibition of Rancidity

It has been shown by previous investigators that the relative susceptibilities of different oils to deterioration can be quantitatively estimated by the peroxide formation. Denison⁷ has shown that the corrosion of bearing metals by lubricating oils will not occur to any appreciable extent if peroxides are not present in the oil. Thus the estimation of peroxides provides a measure of the ability of the oil to bring about corrosion. The effect of oxalic acid in inhibiting peroxide formation under oxidizing conditions was carefully studied.

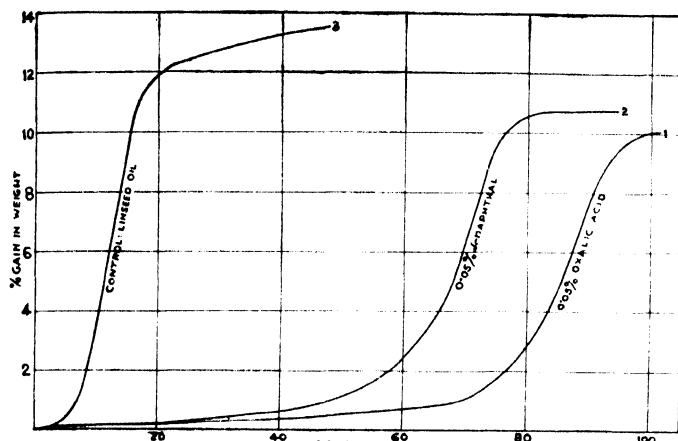


Fig 1. Drying rate of linseed oil.

The method employed consists in passing a slow stream of moisture-free air through a long narrow column of oil at 100° C. 7.5 litres of air were bubbled through 50 gms. of refined groundnut (*Arachis hypogæa*) oil in long test tubes immersed in a boiling water bath. Various additives were added to the oil. The quantities of peroxide developed after 6 hours and 12 hours were estimated. The results obtained are given in Table I.

TABLE I. Refined Groundnut Oil with 0.05 per cent. additives.

Additives	Increase in Peroxide value per 100 gms. of oil after	
	6 hours.	12 hours.
Control without additive	400.5	519.7
α-Naphthol		33.2
Oxalic acid	15.0	88.2
Succinic acid	180.1	394.9
Adipic acid	190.0	416.3
Sebacic acid	213.8	446.4

Only oxalic acid among the additives studied has any pronounced anti-oxidant value.

Prevention of Bearing Corrosion

In actual service, the presence of metals introduces another factor of corrosion, besides oxidation of the lubricant. Oxidation of the oil itself is accelerated by metals and metallic compounds formed during oxidation, but corrosion of bearings caused by the presence of the metal presents a more serious problem. The usual anti-oxidants like α-naphthol are unsatisfactory. Oxalic acid and its higher homologues seem to possess the desired property of suppressing corrosion.

The study of the action of the oxalic acid series consisted of both laboratory investigations and service tests carried out under factory conditions. The behaviour of lubricants in actual use can be studied only after a considerable lapse of time, and the results are often vitiated by carelessness on the part of operators. A laboratory test was adopted to give in a short time an indication of the behaviour of treated oils. The procedure adopted was to subject the oil to oxidizing conditions more severe than those obtaining in actual service. 50 c.c. of the oil samples,

with and without the additives, were heated in small open beakers at a temperature of 150° C. for 5 hours. Weighed polished strips of brass were kept half immersed in the oil. This enabled comparative visual study of the effects, such as tarnishing, on the metal strips. The loss in weight of the brass strips gave a measure of the corrosion.

Tables II, III and IV give the results of the experiments.

The Acid Value of the oil increases on oxidation. The free acids, incipient and those generated during the test, are used up in attacking the metal, with the result that when the amount of brass dissolved is high, the acid value is actually low. The addition of oxalic acid checks the corrosion. From Tables III and IV it will be seen that the inhibiting action increases with the higher members of the series.

TABLE II. Blown Rapeseed Oil with Oxalic Acid as Inhibitor

	Brass dissolved mgms.	Acid value mgms. of KOH per gm. of oil	Colour: Lovibond scale.
Control without additive	4.1	2.5	61/500
Oxalic Acid 0.012%	3.5	2.6	58/500
" " 0.025%	2.9	2.9	54/500
" " 0.05%	0.8	3.4	40/500

TABLE III.

	Brass dissolved mgms.	Acid value mgms. of KOH
Control	4.0	1.80
Oxalic acid 0.05%	0.8	1.93
Succinic acid 0.05%	nil	2.86

TABLE IV. *Rapeseed Oil + Members of the Oxalic Acid Series*

Inhibitor	Brass dissolved mgms.	Acid value mgms. of KOH.
Control	5.6	1.23
Oxalic Acid 0.025%	5.0	1.28
Succinic Acid 0.025%	1.7	1.34
Adipic Acid 0.025%	1.1	1.44
Sebacic Acid 0.025%	1.0	1.46

The deciding step in the study of a lubricant is to use it in actual service. Several blends of mineral-vegetable oils were tested in factories. Laboratory analyses were made on these blends before and after use. Tables V and VI give the results. The tests were made on line shaft brass ring oil bearings in a cotton mill working 24 hours a day.

Corrosion of the bearings by the oil is determined by estimating the amount of copper dissolved in 100 gm. of the oil. All viscosity figures are in Redwood Seconds at 140° F. The colour of the used oil gives a rough idea of the deterioration of the oil.

TABLE V. *Rapeseed Oil + Mineral Oil Blend Used in Ring Oiled Bearings.*

Description	Viscosity Redwood Secs.	Acid value mgms. of KOH.	Copper content mgms.	Colour
1. Blend unused	91.4	1.5	..	Amber
2. Blend without additive, used 34 days	103.2	2.32	42.85	Dark green
3. Blend + 0.1% α -naphthol used 34 days	95.3	1.8	21.42	Dark
4. Blend + 0.05% ethyl oxalate used 29 days	94	2.15	trace	Amber
5. Blend + 0.05% ethyl oxalate + 0.1% α -naphthol used for 29 days	92.2	2.2	..	Dark brown in deep, and red in thin layers.

TABLE VI. *Groundnut Oil + Mineral Oil Blend Used for 36 Days.*

Description.	Viscosity Redwood Secs.	Acid value mgms. of KOH.	Copper content mgms.	Colour: Lovibond scale.
1. Blend unused	91.0	1.70	..	Amber 14/500
2. Blend used without additive	97.5	1.90	53.63	Dark 375/500
3. Blend + 0.05% ethyl oxalate	148.0	6.40	1.21	Brown 71/500
4. Blend + 0.05% oxalic acid	128.0	4.25	1.02	Brown 52/500
5. Blend + 0.05% ethyl oxalate + 0.1% α -naphthol	97.7	2.10	1.47	Dark Brown 77/500

Discussion

The results bring out the well established property of α -naphthol in reducing the oxidation of the oil as indicated by a low

increase in viscosity. But metallic corrosion is minimized only to the extent that the oxidation is lessened.

The addition of oxalic acid or ethyl oxalate, besides inhibiting oxidation to some extent, has the distinct property of checking the corrosion of the metal bearings as shown by the low copper content of the used blends. This specific property of oxalic acid seems to be the prevention of the deleterious action of the oxidation products on the metal surface. How this action comes into play cannot be explained with the available data. It may be due to the formation of a thin protective film of oxalate on the metal thus keeping apart the metal surface and the oxidation products.

Oxalic acid in combination with an effective anti-oxidant, like α -naphthol, has proved highly efficient. Corrosion of the bearings as well as the oxidation of the oil are inhibited.

These results are in accordance with those obtained in the laboratory by adopting accelerated tests.

The work is covered by the Indian Patent No. 29408 (1943).

The tests under actual service conditions were made in collaboration with Mr. McCarthy of Messrs. *Burmah-Shell Co., Ltd.*, New Delhi.

References

- 1 Aggarwal and Verman, *Bull. Indian Ind. Res.*, No. 18.
- 2 Aggarwal, Chowdhri, Mukerji and Verman, *Bull. Indian Ind. Res.*, No. 20.
- 3 A. F. Underwood, *S. A. E. Journal*, 1938, 43, 385 T.
- 4 Chatterji and Finch, *J. Soc. Chem. Ind.*, 1926, 45, 333 T.
- 5 Nicholson and Holly, *Ind. & Eng. Chem.*, 1938, 30, 114.
- 6 Nicholson, *Ind. & Eng. Chem.*, 1938, 30, 563.
- 7 Denison, *Ind. & Eng. Chem.*, 1944, 36, 477.

MANUFACTURE OF POTASSIUM CHLORATE

By B. SHAH

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Introduction

POTASSIUM chlorate is an important constituent of the dipping composition of matches. The normal annual requirement of the Indian match industry is of the order of 1,600 tons and this was being met largely from supplies from Sweden, Germany and Japan in the pre-war years. During the early part of the present war, an acute shortage of potassium chlorate was experienced. The war-time need for flares and explosives resulted in a further demand on the limited stocks of the chemical available in India, and there being no indigenous production, the prices rocketed to the ridiculous limit of one rupee an ounce! The need for indigenous production became urgent.

The Council of Scientific and Industrial Research sanctioned a scheme in 1941 for the investigation and development of a suitable process for the manufacture of potassium chlorate in India. This work was carried out in the laboratories of the *Indian Institute of Science, Bangalore*; a plant for its commercial manufacture was set up at the *Mettur Chemical and Industrial Corporation Ltd., Mettur Dam*.

The Process

Two processes for the manufacture of potassium chlorate are in use:—(1) the direct electrolytic process and (2) the indirect chemical process. In the first process, a solution of potassium chloride is electrolysed and the resulting products brought together to facilitate the reaction between them. The alkali hydroxide reacts with the chlorine to form chlorate which crystallizes out on cooling the solution. In the second process, a slurry of lime or magnesia is chlorinated, the chlorine being obtained by the electrolysis of sodium chloride, usually from an alkali cell. The resulting calcium or magnesium chlorate is converted into potassium chlorate by double decomposition on treatment with a potassium salt.

The chemical process has recently assumed great importance; it is rapidly replacing the electrolytic process. The process makes use of the by-product chlorine, whose disposal

presents a serious problem; the growing production of caustic soda has resulted in a considerable surplus of chlorine. The advantages of the chemical process over the electrolytic process are briefly as follows:—

- (a) The consumption of electrodes are minimized since the chlorate reaction takes place outside the cell.
- (b) A valuable product, caustic soda, is recovered which otherwise would have been consumed during the formation of chlorate, and
- (c) The production of chlorine compounds can be regulated to suit market demands. Other products such as bleaching powder, hydrochloric acid, organic chlorine compounds or liquid chlorine can be produced as required. This is an important consideration since the price of potassium chlorate suffers heavy fluctuations in striking contrast to that of caustic soda.

Raw Materials

The chief raw materials required in the chemical process are chlorine, lime and a potassium salt. With the exception of potassium salt, all the materials are available in an alkali factory. The moist chlorine as obtained from the electrolytic cells, and the slaked lime used in feeding the bleaching powder towers suit admirably. Crude potassium chloride recovered during the purification of potassium nitrate from the nitre deposits of North India was found to be quite suitable.

Manufacture

The flow-sheet diagram (Fig. 1) indicates the sequence of operations in the process.

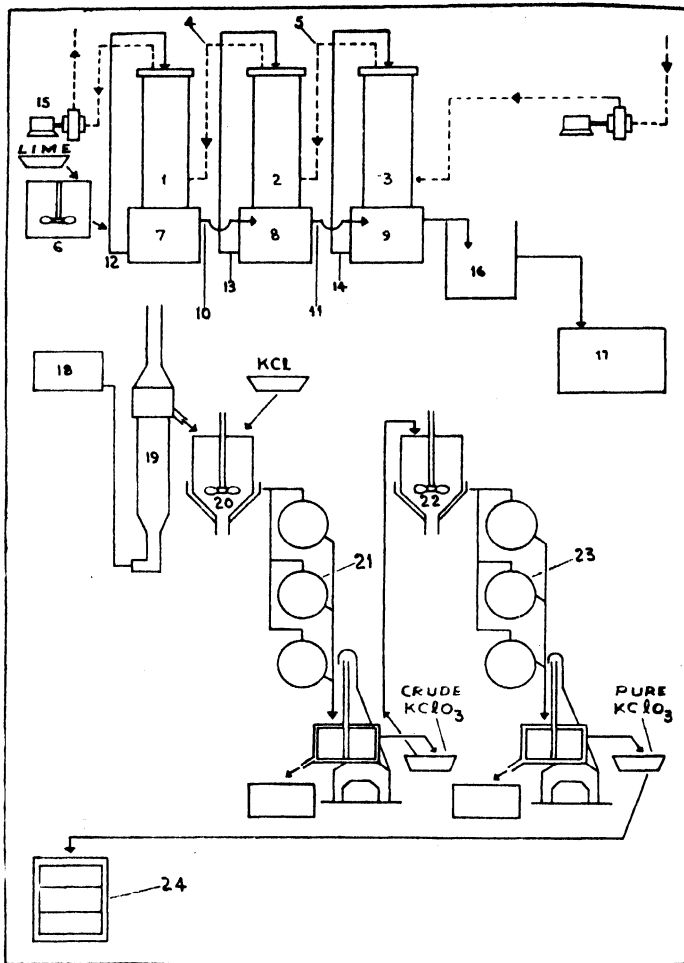
The chlorine is obtained from a batch of Siemens Billiters cells in the cell-house of the alkali plant in the Mettur Dam. The cells have a horizontal diaphragm, and work to a maximum capacity of 6,000 amps. and a voltage of 3.6 volts per cell. At full load, each cell can generate about 0.2 ton of chlorine in a day of 24 hours. The chlorine generated at the anodes assemble in the space between the brine and top cover of the cells and has to be exhausted by means

of a fan to the consumption unit. The draw of chlorine has to be uniform and any fluctuations will interfere in the normal working of the cell. An absorption system was designed to obviate the fluctuations and ensure satisfactory working conditions.

Absorption System.—Three towers (1, 2 and 3 in Fig. 1) are connected in series by means of pipes (dotted lines 4 and 5) through which chlorine is conveyed. The slurry of lime is prepared in a tank (6) and fed into reaction tanks (7, 8 and 9) to the overflow level. All the tanks are inter-connected by means of overflow tubes (10 and 11) and are placed below the towers. The towers are connected to the reaction tanks by a water seal which prevents the leakage of chlorine into the tanks or to the outside atmosphere, and at the same time prevents air from entering into the towers.

Tower (3) is provided with two outlets at the water seal. One leads to the reaction tank and the other to the settling tank (16). The slurry is circulated from the reaction tanks in the respective towers through the pipes (12, 13 and 14). The circulation is effected by means of centrifugal pumps placed on the sides of the reaction tanks. The towers are packed with cement baffles to distribute the liquor and help the complete absorption of chlorine which it meets in the counter current direction. The chlorine enters from the tower (3) farthest away from the slurry tank (6) and passes in series through the three towers (3, 2 and 1), the excess gas being exhausted by means of a fan (15). All the towers are cooled by water sprays.

The maximum absorption takes place in tower (3), the gas that remains over is absorbed in towers (2) and (1). When the liquor in tank (9) is fully chlorinated, the maximum absorption takes place in tower (2), the remaining gas being absorbed in tower (1). Then Superchlorination takes place in tower (3).



Adjustable openings are provided on the chlorine line entering tower (3) to facilitate the drawing in of air and so to dilute chlorine. An opening is also provided for drawing out samples of gas for estimating their chlorine content.

Decomposition of Hypochlorite.—The clear liquor from the settling tank (16) is drawn into an underground storage tank (17) and heated by a steam coil after adding starch in the form of rice flour. When all the hypochlorite is decomposed, the solution is pumped into an overhead feed tank (18), rendered slightly alkaline by the addition of a small quantity of caustic soda, and finally concentrated to the desired density in a set of film evaporators (19).

The evaporator consists of six stainless steel tubes enclosed in a steam jacket,

and a liquid separator at the top to separate the concentrated solution from the steam. The concentrated solution is led into a steam-heated pan (20) provided with agitators and treated with the calculated amount of potassium chloride; when all the chloride has dissolved, the hot solution is drained into a set of crystallizers (21) which are cooled by a spray of water; when the solution cools down to the room temperature, crude potassium chlorate crystallizes out and is separated by centrifuging. The mother liquor is pumped into an insulated tank provided with ammonia expansion coils where it is cooled down to 0° C. A second crop of potassium chlorate crystals are thus obtained and are removed by centrifuging. The mother liquor is drained into a storage tank for use as required.

Recrystallization.—The crude product is dissolved in water (or the mother liquor obtained from a previous recrystallization) in a steam-heated pan (22) provided with agitators, and the temperature raised to the boiling point. The undissolved impurities are allowed to settle, and the clear, hot solution decanted to a set of crystallizers (23) and cooled to the room temperature by a spray of water. Pure crystals of potassium chlorate separate. They are removed by centrifuging and dried in a hot air drier (24). The mother liquor is used for the next recrystallization. It is usual to employ the mother liquor over and over again for recrystallization until the calcium chloride content rises to about 5 per cent. It is then pumped back to the evaporators for being concentrated along with the liquor from the towers.

Under optimum working conditions the approximate yields at various stages are as follows:—

Calcium chlorate formed—90 per cent. on the basis of chlorine consumed.

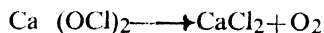
Potassium chlorate obtained as crude crystals—80 per cent. based on the calcium chlorate content of the solution.

Potassium chlorate obtained as pure crystals—97 per cent. of the crude crystals treated.

It will be seen that the yield of pure potassium chlorate is roughly 70 per cent. of the theoretical, calculated on the basis of chlorine consumed.

The following observations made during the operation of the factory plant may be of interest.

With lime containing carbonate, there was considerable frothing of liquors during chlorination. When the carbonate content was high, the frothing was so vigorous that it overflowed the reaction tanks and choked the chlorine lines. A similar phenomenon was observed with slurries of high concentration when the temperature of the liquor exceeded 40° C. This resulted in a reduction in the yield of chlorate with respect to the chlorine consumed. The reduction in yield is due to a secondary reaction, resulting in the evolution of oxygen



At the completion of the reaction the fall in the hypochlorite content of the solution was accompanied by a change in colour from white to pink. This was attributed to the formation of ferrates.

The chlorine lines, the liquor lines and the pumps have to be cleaned constantly to avoid choking. Otherwise, pressure develops in the chlorine compartment of the cells and escapes into the atmosphere. With slurries of high concentration, the choking of pumps and liquor lines was more frequent.

It was not found possible to prevent the leakage of chlorine and hypochlorous acid during the superchlorination stage. The only remedy was to isolate the absorption system from the rest of the plant and house it preferably in an open shed. The smell of hypochlorous acid is particularly irritating. A gas-mask filled with sodium thiosulphate crystals was found to give good protection.

The chlorinated liquors are highly corrosive. Wherever possible, cast iron parts have to be substituted by acid-resistant stoneware. Shafts are also rapidly attacked and have to be frequently renewed. Cast iron impellers and shafts with sleeves of phosphor bronze have a longer life. Chlorine exhaust fans with ebonite impellers serve the purpose well.

Acknowledgment

I am grateful to Sir J. C. Ghosh, and Dr. S. K. K. Jatkar for their keen interest, helpful suggestions and criticisms during the course of this investigation, and to the *Council of Scientific and Industrial Research* for providing the funds. I am also grateful to the *Mettur Chemical and Industrial Corporation Ltd., Mettur Dam*, for permission to publish the general details of the plant.

THE IODINE CONTENT OF THE THYROID GLANDS OF SHARKS

By B. B. DEY, P. S. KRISHNAN AND M. GIRIRAJ

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IT is known that diet influences the iodine content of the thyroid gland. As iodine occurs in higher concentration in the sea than on land (sea weeds are rich sources of iodine¹), it has been a popular belief² that the thyroids of sea animals are richer in iodine than those of the land animals.

The iodine content of fish thyroids was carried out by Cameron and his associates. Two female specimens of dog fish (*Scyllium canicula*) yielded the surprisingly high figure of 1.16 per cent. for total iodine on the basis of the dried material, when analysed by Hunter's method; a male specimen, however, analysed only 0.719 per cent³. Based on these isolated investigations, Cameron⁴ suggested that there existed a sex difference in the iodine content of the thyroids, the female containing a higher percentage of iodine. Subsequently more elaborate investigations by the same author on elasmobranch fish led him to conclude that the females do not contain any more iodine than the males⁵. The thyroids of a large number of male and female specimens of dog fish (*Squalus*) were analysed systematically⁶: the male fish, weighing on the average 2.3 kg., yielded a gland weighing on the average 0.091 gm. whilst the corresponding figures for the female shark were 5.1 kg. and 0.183 gm. respectively; the iodine content of the dried thyroid was practically the same in both cases; 0.21 per cent. for the male and 0.189 per cent. for the female. Analyses of a number of rat fish (*Hydrolagus*) yielded, on the average, 0.620 and 0.609 per cent. respectively for the total iodine contents of the dried glands of males and females.

The present communication deals with the analyses of the thyroid glands of sharks caught by the Deep Sea Fishing Department, Madras. They were captured by the hook and line method and were available in a fairly fresh state. The sharks belonged mostly to two genera *Galeocerdo* and *Carcharias*; occasionally sharks of the *Scoliodon* genus also were available. They measured on the average from 8' to 14' in length and weighed

from 300 to 700 lbs. The thyroid gland was a compact organ situated at the anterior end of the ventral aorta, in front of the bifurcation of the 1st bronchial arteries: the glands which were thin and flat were brownish red in colour and conspicuous against an almost white background. The glands were cut out from the fish along with connective tissue and adhering flesh and removed to the laboratory where they were trimmed clean from extraneous matter. The glands of sharks belonging to the two genera *Galeocerdo* and *Carcharias* showed characteristic differences in morphological features: the thyroid of *Galeocerdo* had a prominent hump on the dorsal side, whilst the glands of *Carcharias* did not have any prominent hump; on the other hand, they were characterized by the fact that the anterior extremity was elongated more prominently and prolonged to a point.

Similar characteristic morphological distinctions between various species have also been observed in the case of the pancreas of the sharks.⁷

The dressed glands were accurately weighed and dried at a temperature of 60° C.; they were then weighed and ground to a fine powder and Soxhleted with acetone for the removal of fat. The fat-free powder was dried in vacuo to remove the last traces of acetone, weighed and passed through a 60 mesh sieve. The analyses of total and thyroxine iodine were carried out on the resulting powder, which had a pale colour and a characteristic fishy odour.

For the isolation of thyroglobulin, the glands were cut into small pieces and extracted with alkaline sodium chloride solution according to the technique of Harington and Salter⁸; the protein was coagulated by heat and dried by means of acetone. It was obtained in the form of a white powder with a characteristic fishy odour.

The estimations of total and thyroxine iodine were carried out according to standard methods described in B.P. 1932 and Addendum 1936. The values are represented in Tables I—VI:

Total Iodine Content of Desiccated Shark Thyroid

TABLE I. *Galeocerdo*—Female

Month	Length of shark inches	Wt. of shark lbs.	Wt. of thyroid gm.	Moisture content %	Fat in dried gland %	Total I. in dried powder %
September	134	422	5.0	80	17	0.4370
October	109	308	2.3	80	15	0.1559
November	105	320	5.4	86	19	0.4184
*December	120	606	..	..	..	0.3257
January	..	..	2.8	85	21	0.3193
"	118	205	1.8	74	25	0.1048
"	80	135	1.3	73	27	0.1048
*March	136	465	10.2	84	20	0.4854
"	138	652	5.4	80	19	0.3857
"	144	702	6.1	80	20	0.3717
"	102	213	4.0	80	19	0.2839
April	136	579	4.3	76	15	0.5768
May	108	300	3.2	80	18	0.3097
"	122	497	3.9	80	21	0.4259
June	119	264	3.7	84	19	0.3024
"	122	434	5.4	80	17	0.1816
"	152	617	7.9	82	15	0.3359
"	140	607	6.5	79	18	0.3702
Average			4.7	80	18	0.3269

*Pregnant animals.

TABLE II. *Galeocerdo*—Male

September	131	460	5.1	88	24	0.2640
"	133	411	5.0	82	19	0.3830
"	143	594	4.8	80	14	0.4452
November	..	..	3.9	86	13	0.2103
"	120	360	4.3	86	25	0.2440
January	113	290	5.0	85	18	0.3120
"	119	390	4.5	77	19	0.6277
"	103	290	4.3	82	19	0.3281
"	96	220	2.7	86	23	0.2856
February	105	..	2.6	84	14	0.3339
"	99	..	2.1	83	14	0.2221
"	106	..	3.4	86	19	0.4158
March	108	185	2.0	85	22	0.2390
"	105	217	3.2	79	22	0.3021
"	112	250	6.8	83	17	0.4989
April	94	179	2.4	82	23	0.2056
Average			3.9	83	19	0.3324

The thyroid gland of a female ray (*Trygon*) was also analysed. Unlike in the case of the sharks, the gland had a hard and rounded structure and could be easily trimmed free from connective sheath. The gland weighed 13.3 gm. in the fresh state and had a moisture content of 84 per cent.; the dried solid contained 19 per cent. of material extractable by acetone and the final desiccated powder analysed 0.33 per cent. for total iodine.

The main results are summarized below:—

- (1) Shark thyroid contains about 77 to 80 per cent. of water; the fat content of the dried solid is about 17 to 19 per cent.; the final desiccated powder is obtained in yields of 16 to 18 per cent. of the weight of the fresh glands.
- (2) The total iodine content of desiccated thyroid varies on the average from 0.33 per cent. to 0.43 per cent.; about 32 to 47 per cent. of the total iodine is represented by thyroxine iodine.

Whilst the ratio of thyroxine iodine to total iodine remains practically the same for the desiccated shark as well as cattle thyroid, the latter contains a much higher concentration of total iodine.⁹ Shark thyroglobulin analyses about 0.65 per cent. of total iodine. The high figures (1.16 per cent.) obtained by Cameron for dried shark thyroid could not be confirmed by the present investigations.

- (3) The thyroid glands of sharks of the genus *Carcharias* are usually bigger than those of sharks of the genus *Galeocerdo*; also they contain a slightly higher iodine percentage; the former analyse about 0.41 per cent. and the latter about 0.33 per cent. on the average for the total iodine of the desiccated powder. The ratio of thyroxine iodine to total iodine is, however, higher in the case of desiccated thyroid of the

TABLE III. *Carcharias*—Female

Month	Length of shark inches	Wt. of shark lbs.	Wt. of thyroid gm.	Moisture content %	Fat in dried gland %	Total I in dried powder %
*November	118	390	17.9	82	11	0.4013
January	120	462	14.6	77	16	0.4354
"	120	462	27.3	82	11	0.4000
*March	105	320	14.4	76	16	0.4102
May	118	355	15.7	77	16	0.4816
"	110	400	21.5	80	16	0.5116
"	108	300	11.8	82	19	0.3665
Average			17.6	79	15	0.4295

* Pregnant animals.

TABLE IV. *Carcharias*—Male

December	93	170	6.0	66	23	0.3881
March	143	450	16.9	78	13	0.4173
April	96	271	8.4	79	15	0.4315
May	96	195	10.8	75	16	0.4294
"	110	395	12.8	77	17	0.4173
"	112	370	11.3	80	17	0.4416
"	110	305	7.4	83	17	0.3951
Average			10.5	77	17	0.4186

TABLE V. *Scoliodon*

Month	Length of shark inches	Wt. of shark lbs.	Sex	Wt. of thyroid gm.	Moisture content %	Fat in dried gland %	Total I. in dried powder %
August	51	28	female	0.56	86	25	0.3995
April	48	25	male	0.34			
May	60	45	female	2.2	83	14	0.6301
				0.67	82	10	0.1200
				0.67			

TABLE VI. Thyroxine-iodine Content of Desiccated Shark Thyroid

Source		Total Iodine %	Thyroxine Iodine %	Thyroxine I Total I
<i>Carcharias</i>	Male	(1) 0.4164	0.1483	35.62
		(2) 0.4130	0.1468	35.55
	Female	(1) 0.4027	0.1349	33.50
		(2) 0.4786	0.1562	32.64
<i>Galeocerdo</i>	Male	(1) 0.3700	0.1635	44.19
		(1) 0.4260	0.1883	44.21
	Female	(2) 0.4814	0.2272	47.20
		(3) 0.3977	0.1692	42.54

Galeocerdo species (average: 44.5 per cent.) than in the case of the desiccated thyroid of *Carcharias* (average: 34.3 per cent.).

- (4) The glands of the female are as a rule heavier than those of the male, but there is practically no difference in the iodine percentage. An increase in the weight of the gland is usually met with during pregnancy.
- (5) The analyses of the glands were spread over a year but no significant seasonal variation in the iodine content could be observed.

Our thanks are due to the Council of Scientific and Industrial Research for financ-

ing this research and to the Deep Sea Fishing Department, Madras, for facilities in the collection of the glands.

References

- 1 McClendon, *J. Biol. Chem.*, 1933, 102, 91.
- 2 Harington, *The Thyroid Gland*, 1932.
- 3 Cameron, *Biochem. J.*, 1913, 7, 466.
- 4 " *J. Biol. Chem.*, 1914, 18, 335.
- 5 " *Ibid.*, 1915, 23, 1.
- 6 " *Endocrinology and Metabolism*, 1924, Vol. 1, p. 243.
- 7 Chithambaram, *Private Communication*.
- 8 Harington and Salter, *Biochem. J.*, 1930, 24, 456.
- 9 Dey, Krishnan and Giriraj, *Curr. Sci.*, 1943, 12, 272.
- 10 Setna, *J. Sci. & Ind. Res.*, 1945, 3, 303.



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AN ECONOMIC MINERALS BUREAU FOR INDIA

IN his presidential address to the *Geological, Mining and Metallurgical Society of India* (24th September 1945), Sir Cyril Fox dwelt at length on the need for establishing an *Economic Minerals Bureau* for India. The *Society* has devoted expert attention during the past year to the inauguration of such an organization with intelligence and laboratory sections and ancillary services. In March 1945, the *Society* issued a questionnaire to "industrialists and others who were commercially and scientifically interested in the mineral resources of India," defining the more important objects of the Bureau and inviting opinions. The objects were, firstly, to supply mineral and metal facts of interest to Indian entrepreneurs, secondly, to carry out laboratory assays, chemical analyses and physical tests for industrial purposes, and thirdly, to register technologists for geological surveys, mineral prospecting and opening of ore deposits. A controlling body consisting of geologists, engineers and representatives of trade and commerce was proposed for guiding the activities of the bureau. The capital expense required for setting up such an organization was estimated at two lakhs of rupees and the fees received for the services rendered by the bureau were expected, in course of time, to meet all the recurring expenses, although in the initial stages, funds would have to be provided for payments to staff and other

expenses. From the replies received it would appear that there was overwhelming support for the early inauguration of the bureau.

The existing organizations, official and non-official, for the dissemination of minerals intelligence, analytical data and mineral statistics, and for surveying and proving India's mineral resources, are woefully inadequate. After the Great War of 1914-18, it was believed that India was poorly endowed with minerals. This opinion altered radically as more and more facts accumulated, and it is now believed that India is richly endowed with minerals. The truth is that there has been no comprehensive appraisal of India's mineral resources. Such knowledge as we possess is scrappy and this is a handicap for post-war development. War-time investigations of the *Geological Survey of India* have indeed revealed the existence of minerals which had hitherto not been sufficiently or efficiently exploited. The need for a more thorough survey of the resources than had so far been attempted, and for thoroughly examining, identifying, assaying and commenting on known minerals has become increasingly urgent. The Government of India, in appreciation of the prevailing deficiencies, have recently formulated proposals for expanding the *Geological Survey of India* to enable it to undertake extensive exploration of the country's mineral resources and assist post-war plans for industrial and

economic development. This welcome and long overdue expansion will accelerate the field activity of the *Survey* and there will be an increasing need for proving the industrial value of minerals. Provision has been made in the Government scheme for meeting this need. The official activity will not in any way minimize or render superfluous unofficial activities such as the one adumbrated by the *Geological, Mining and Metallurgical Society*. The problems awaiting attention are so many and of such a variety that there is scope for an enhancement of both official and unofficial activities. There is a large field for the latter, specially in regard to intelligence and analytical services; unofficial bureaux can serve as useful channels for the supply of professional geologists and mining experts required for the industrial exploitation of proved mineral deposits.

The proposed *Economic Minerals Bureau* will not be a research body. Research work in the field of minerals and metals, and surveys of resources, will largely vest in official organizations. The bureau will supplement, but in no way duplicate or supplant, the work of existing organizations. It will not be State-aided or State-controlled but it will co-operate with any geological, mining

and scientific institution and with the Government. Its function will be largely the dissemination of facts relating to mineral fuels, iron and ferro-alloy minerals, base metal minerals, precious metals and stones, minerals for chemical industries, industrial earths and clays and miscellaneous minerals, for the benefit of industrialists, and to provide quantitative data on the availability and suitability of minerals for industries. It will also help in the collection and dissemination of mineral statistics. In fact, it will have functions analogous to those of the *Mineral Resources Department* of the *Imperial Institute, London*, which deals with a variety of problems ranging from the nature and occurrence of raw materials to the manifold problems relating to their marketing and uses. The move for the inauguration of the *Economic Minerals Bureau* has come none too soon. It will greatly facilitate mining enterprise and progress and will be a most valuable aid to the economic development of India. The project sponsored by the *Geological, Mining and Metallurgical Society of India* will, we trust, have the financial support of Indian industrialists and we hope that its inauguration will not be unduly delayed.

GERMAN WAR RESEARCH

THE article on German War Research and Development appearing in this number,* and the two articles that will follow in subsequent numbers of the journal, are based on the reports of the Combined Intelligence Objective Committee, supplied to the Government of India. While the war was still going on, the Committee despatched several teams to survey the ground occupied

by the Allied Forces in Germany and German-occupied territory, and experts were subsequently sent to investigate the targets in greater detail. The investigation of targets and interrogation of key personnel have resulted in valuable information on German industrial methods, techniques and "know how." The articles appearing in the journal, give an idea of the research developments in Germany during the war years.

* Publication permitted by the Government of India.

NATIONAL RESEARCH FOUNDATION, U.S.A.

EXPANSION OF SCIENTIFIC ACTIVITIES IN AMERICA

[A historic document—Science, the Endless Frontier—setting forth a nation-wide programme of scientific research was prepared by Dr. Vannevar Bush and presented to the President of the United States in July 1945, in response to the request of the late President Roosevelt to report on the measures necessary for expanding the spectacular work of the emergency *Office of Scientific Research and Development*, for peaceful purposes. The inspiring document, which draws upon the reports of four representative committees, should be read in original by every literate citizen. The more important points of the report are given below—ED.]

THERE are areas of science in which the public interest is acute but which are likely to be cultivated inadequately if left without more support than will come from private sources. These areas, such as research on military problems, agriculture, housing, public health, medical research and research involving expensive capital facilities beyond the capacity of private institutions, should be advanced by active Government support.

National Health

Since health, well-being and security are proper concerns of Government, scientific progress is, and must be of vital interest to Government. Without scientific progress national health would deteriorate; without scientific progress we could not hope for improvement in our standards of living or for an increased number of jobs for our citizens; and without scientific progress we could not have maintained our liberties against tyranny.

Discovery of new therapeutic agents and methods usually results from basic studies in medicine and the underlying sciences. The development of such materials and methods to the point at which they become available to medical practitioners, requires team work involving the medical schools, the science departments or universities, Government, and the pharmaceutical industry. Government initiative, support and co-ordination can be very effective in this development phase.

The traditional sources of support for medical research, largely endowment income, foundation grants and private donations are diminishing and there is no immediate prospect of a change in this trend. Meanwhile, research costs have steadily risen.

It is clear that if we are to maintain the progress in medicine which has marked the last twenty-five years, Government should extend financial support to basic medical research in the medical schools and in the universities, through grants both for research and for fellowships.

National Security

This war emphasizes three facts of supreme importance to national security: (1) powerful new tactics of defence and offence are developed around new weapons created by scientific and engineering research; (2) the competitive time element in developing those weapons and tactics may be decisive; (3) war is increasingly total war, in which the armed services must be supplemented by active participation of every element of civilian population.

Military preparedness requires a permanent, independent, civilian-controlled organization, having close liaison with the Army and Navy.

As a permanent measure, it would be appropriate to add to the agency needed to perform the other functions recommended in this report, the responsibilities for civilian-initiated and civilian-controlled military research. The function of such a civilian group would be primarily to conduct long-range scientific research on military problems, leaving to the services research on the improvement of existing weapons.

Three Categories of Research

Scientific research may be divided into the following broad categories: (1) pure research, (2) background research, and (3) applied research and development.

Pure research is without specific practical ends. It results in general knowledge and understanding of nature and its laws. Surveys and descriptions of basic facts and the determination of standards, these and other similar types of scientific work grouped together under *background research*, are proper fields for Government action. The results of *applied research* are of a definitely practical or commercial value.

The distinction between applied and pure research is not a hard and fast one, and industrial scientists may tackle specific problems from broad fundamental viewpoints. But it is important to emphasize that there is a perverse law governing research: under the pressure for immediate results, and unless deliberate policies are set up to guard against this, applied research invariably drives out pure. The moral is clear: it is pure research which deserves and requires special protection and specially assured support.

A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill.

Publicly and privately supported colleges and universities and the endowed research institutes must furnish both new scientific knowledge and the trained research workers.

Research Expenditure

Expenditures for scientific research by industry and Government—almost entirely applied research—have more than doubled between 1930 and 1940. Whereas in 1930, they were six times as large as the research expenditures of the colleges, universities

and research institutes, by 1940 they were nearly ten times as large.

While expenditures for scientific research in the colleges and universities increased by one-half during this period, those in the endowed research institutes have slowly declined.

If the colleges, universities and research institutes are to meet the rapidly increasing demands of industry and Government for new scientific knowledge, their basic research should be strengthened by use of public funds.

Research within the Government represents an important part of our total research activity and needs to be strengthened and expanded. Such expansion should be directed to fields of inquiry and service which are of public importance and are not adequately carried on by private organizations.

Government Responsibility

The most important single factor in scientific and technical work is the quality of personnel employed. A general upgrading of positions and salaries in the scientific services of Government accompanied by a careful selection of new talent, would be a major contribution to improvement of the quality of research conducted by the Government.

Research programmes of Government should be assured in terms of their long-run objectives. The simplest and most effective way in which the Government can strengthen industrial research is to support basic research and to develop scientific talent.

International exchange of scientific information is of growing importance. Increasing specialization of science will make it more important than ever that scientists in this country keep continually abreast of developments abroad. In addition, a flow of scientific information constitutes one facet of general international accord which should be cultivated.

The Government can accomplish significant results in several ways: by aiding in the arrangement of international science congresses, in the official accrediting of American scientists to such gatherings, in the official reception of foreign scientists of standing in this country, in making possible a rapid flow of technical information including translation service and possibly in the provision of international fellowships. As an experiment, scientific attachés should be appointed to serve in certain selected U.S. embassies.

An Agency of Action Required

One lesson is clear from the reports of the several committees. The Federal Government should accept new responsibilities for promoting the creation of new scientific knowledge and the development of scientific talent in our youth.

The effective discharge of these responsibilities will require the full attention of some overall agency devoted to that purpose. There should be a focal

point within the Government for a concerted programme of assisting scientific research conducted outside of Government. Such an agency should furnish the funds needed to support basic research in the colleges and universities, should co-ordinate, where possible, research programmes on matters of utmost importance to the national welfare, should formulate a national policy for the Government towards science, should sponsor the interchange of scientific information among scientists and laboratories both in this country and abroad, and should ensure that the incentives to research in industry and the universities are maintained.

National interest in scientific research and scientific education can best be promoted by the creation of a National Research Foundation. Responsibility to the people through the President and the Congress, should be placed in the hands of, say, nine members, who should be persons not otherwise connected with the Government and not representative of any special interest, who should be known as National Research Foundation members, selected by the President on the basis of their interest in and capacity to promote the purposes of the Foundation.

In order to accomplish the purposes of the Foundation, the members should establish several professional divisions to be responsible to the members. At the outset these divisions should be: (1) Division of Medical Research, (2) Division of Natural Sciences, (3) Division of National Defence, (4) Division of Scientific Personnel and Education, and (5) Division of Publications and Scientific Collaboration.

The success of the National Research Foundation in promoting scientific research in this country will depend to a very large degree upon the co-operation of organizations outside the Government. In making contracts with or grants to such organizations, the Foundation should protect the public interest adequately and at the same time leave the co-operating organizations with adequate incentive to conduct scientific research. The National Research Foundation must be free to place its research contracts and grants not only with those institutions which have a demonstrated research capacity but also with other institutions whose latent talent or creative atmosphere affords promise of research success.

Studies by the several committees provide a partial basis for making an estimate of the order of magnitude of the funds required to implement the proposed programme. Clearly the programme should grow in a healthy manner from modest beginnings. An expenditure of 33.5 million dollars in the first year of operation, rising to 122.5 million dollars in the fifth year when it is expected that the operation will have received a fairly stable level, is suggested.

Early action is imperative, however, if this nation is to meet the challenge of science and fully utilize the potentialities of science. On the wisdom with which we bring science to bear against the problems of the coming years depends in large measure our future as a nation.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

THE following communication has been received by Mr. D. N. Wadia, President, National Institute of Sciences of India, from the Education Department, Government of India :—

NEW DELHI,
17th October, 1945.

"I am glad to inform you that the Government of India have decided to recognize the National Institute of Sciences of India as the premier Scientific Organization in this country. The question of granting a Royal Charter to the National Institute has also been taken up by the Government of India with His Majesty's Government and it is hoped a decision will be available in the very near future."

In this connection it may be recalled that during the deputation of Prof. A. V. Hill to India last year, as a result of certain discussions between him and the Council of the National Institute on the one side and the Government of India on the other, an agreement was reached that the following changes in the rules and procedure of the National Institute should be made in order to secure formal recognition of the Institute as the society occupying a position relative to academic science on the one hand and Government organizations on the other, corresponding to that of the Royal Society of London or the National Academy of Washington :—

- (i) Delhi should be the headquarters of the National Institute.
- (ii) The National Institute should have a Charter and should have Statutory powers on the model of the Royal Society of London.
- (iii) There should be provision for travelling allowance to members of Council visiting three or four Council meetings at different centres of India.
- (iv) All these conditions should stand together, and
- (v) The Institute should have a calendar (programme of General meetings, Council meetings, Symposia, etc.) to be fixed at the beginning of the year.

Since December 1944, this matter was under negotiation between the Council of the Institute and the Education Department of the Government of India, the result of which has been the formal announcement by Government made in the letter quoted above. In order to efficiently discharge the duties and functions implied in the new status, the Institute will have

- (i) to act as Advisers to Government on all scientific matters,
- (ii) to secure and manage funds and endowments for the promotion of science,
- (iii) to effect co-ordination between scientific academies, societies, institutions and Government scientific departments and services,
- (iv) to do such other things as may be necessary for organizing scientific work in India, and
- (v) to arrange for meetings of the Council and the General Body of Fellows, arrange symposia, etc.

Scientific meetings are held regularly at present and symposia and discussion meetings at different centres are arranged from time to time. A series of transactions, proceedings and Indian Science Abstracts (in part dislocated during the war emergency years) are already being published. A consolidated report on the progress of science in India will have to be published according to programme.

During the last two years, the *Rockefeller Foundation* have given to the National Institute a grant of Rs. 15,000 per year which is being distributed in aid of publications by 23 different scientific societies and organizations. The Directorate of the *Imperial Chemical Industries* has lately donated a sum of Rs. 3,36,000 to the Institute for the award of a number of Research Fellowships in Physics, Chemistry and Biology.

The activities of the Institute have steadily increased and are bound to expand still further on the transfer of its headquarters to Delhi.

NITROUS OXIDE (Concluded from page 276)

minor surgery without taxing the vitality of the patient. After-effects, such as nausea, vomiting, etc., are practically non-existent and recovery is complete in a few minutes. This is a point of great advantage and convenience to both patient and surgeon,

particularly in dental and minor surgery, where accommodation is often limited. The slightly sweet odour of nitrous oxide replaces the much disliked "hospital smell" in a surgery or clinic, which is usually a nightmare to the more timorous.

GERMAN WAR RESEARCH AND DEVELOPMENT *

1. CHEMICAL RESEARCH

THE Combined Intelligence Objectives Subcommittee (C.I.O.S.) set up by the Combined Intelligence Committee, Washington, in August 1944, has unearthed a mass of valuable information on German war research. More than 200 British and American technical experts followed hard on the heels of the invading armies in Europe, and so thorough was the search that despite the fact that the Germans tried to conceal documents in mine shafts and tunnels or bury them in the beds of lakes and rivers, a large amount of valuable material of great technical significance has been obtained. It has been estimated that the German secrets would have saved to the Allies many millions of dollars in research and development if the Pacific War had continued up to the end of the year.

The information which is given here represents but a fraction of the valuable material collected. In several cases, complete blue-prints of processes and all relevant details connected with production were obtained.

The first part of the series gives a brief account of a few of the developments in the chemical industry.

Among the shortages in industrial raw materials which Germany had to face were natural textile fibres (more especially, cotton and wool), rubber, manganese, copper, tin and a few other metals required in the manufacture of special alloy steels. Deficiencies in natural raw materials were overcome to a great extent by canalising scientific research to the development of *ersatz* materials. The production of such materials had reached an unprecedented scale. Through proper organization, industry was allotted raw materials on a system of the strictest priority according to the needs of the German war economy.

Fuel

Exploration of the principal German synthetic oil plants in the Ruhr, Cologne, Frankfurt and Leuna areas of the 12th Army Group and in the Heidelberg area of the 6th Army Group, and the interrogation of highest level I.G. Farben personnel,

has resulted in much valuable intelligence. The complete picture, with all engineering details, of the German liquid fuel industry has been assembled. Any phase of the industry including production of all types of fuels from natural gas, coal or shale, could now be reproduced in the United Kingdom and in the United States of America without many of the delays incidental to the development, experimentation and research. The data include information on special products, aviation and motor fuels, high alcohols, diesel fuels, special lubricants and greases, edible fats and waxes. Data have been collected on formulæ and methods of production of methyl alcohol, acetone and compressed methane gas which is used as an autofuel instead of gasoline.

The *Leuna* hydrogenation plant consists of 10 coal, 5 saturation and 3 splitting stalls. At its production peak early in 1944, the plant processed raw materials at the following rates:—

	Tons per year
Brown coal tar ..	120,000
Bituminous coal middle oils ..	40/50,000
Dried brown coal ..	1,200,000

The production of liquid products was at the rate of 600,000 tons per year, this being made up on the average of 40 per cent. aviation base gasoline, 20 per cent. motor gasoline and 40 per cent. diesel oil.

The most interesting feature of the hydrogenation plant operation is the increase in coal throughput which has been achieved during the war. This has been almost doubled by attention to details rather than by major modification of the process. Adoption of automatic control and the use of a falling temperature gradient in the converter system have contributed most to this throughput improvement. The *Leuna* experience with falling temperature gradient which leads to improved asphalt decomposition, is particularly interesting.

Alkylation Production.—*Leuna* had a capacity of 60,000 tons per year alkylate. The raw materials obtained from the hydrogenation process were first fractionated into *iso* and normal butane. The normal butane was then dehydrogenated in a moving catalyst

* Some of the information contained in this article may have been covered by patent rights, and necessary precautions should be taken in making use of it for commercial purposes.

bed plant and the resulting normal butylene alkylated over sulphuric acid into the *iso*-butane.

Research on Fuel Production Processes.—During the war, *Leuna* had taken over from Ludwigshafen a considerable amount of research and development work. The chief line of development was in connection with processes giving rise to high aromatic content gasoline. Catalytic cracking coupled with high or medium pressure hydrogen saturation of the feed stock and of recycle middle oils had been studied fairly extensively. As an alternative, catalytic cracking under pressure in the presence of hydrogen and with a modified catalyst had been tried out (the Arobin process). Semi-technical research had also been carried out on the 700 ats. gas phase hydrogenation of aromatic middle oil using catalysts of low saturation activity.

A process for the manufacture of alkyl benzenes using C_7 and C_8 alcohols from the higher alcohol process had been developed. *Leuna* also developed the process for making toluene from ethanol and benzene which was being operated on a large scale at Waldenburg.

Synthetic Lube Oil from Ethylene.—Ethylene was obtained at *Leuna* from the oxygen cracking of ethane from the hydrogenation plant. The whole secret of the process is the final purification of ethylene.

In 1938 the production of synthetic fuel in Germany amounted to 68,500 tons per month of which 65,500 tons was from hydrogenation. By the end of 1943 the total production was 333,300 tons per month of which 296,300 tons were from hydrogenation. The production remained approximately constant until the end of April 1944 after which it fell extremely rapidly and was almost completely eliminated by the end of August.

A feature of the Blechhammer and all the latest eastern plants, is the use of a pressure process for conversion of water gas to hydrogen. Considerable difficulty was encountered in all the plants mainly due to corrosion and contamination of catalyst with iron leading to a short catalyst life. The greater part of the hydrogen for this plant was made from coke oven gas obtained from the Upper Silesian Grid. The process involved partial combustion with oxygen.

The primary products of the Heiderbrech plant were methanol, higher alcohols and ammonia. There were three methanol con-

verters with a combined capacity of 80,000 tons per year.

A pressure of 300 ats. was used, and there was 18-20 per cent. CO in the circulating gas. The catalyst was arranged in beds in the converters with arrangements for intermediate cooling. The output of each converter was high; an average over six months' operation of over 150 tons per day for 2.8 cubic meters of catalyst.

The higher alcohol plant was planned to make sufficient *iso*-butyl alcohol to give rise to 80,000 tons per year of *iso*-octane. Actually half this production was reached. The crude product consisted of 55 per cent. methanol, 10 per cent. *iso*-butyl alcohol, 1.2 per cent. propyl alcohol, 18/20 per cent. water, 13.8-15.8 per cent. higher alcohols. The rate of production of this crude product was 150 tons per day per converter of 2.8—3.0 c. meter capacity. Methanol was recycled to the reaction. The higher alcohols were hydrogenated at 300 ats. over a nickel and silica catalyst, and later over Dutch oxide to give an *iso*-paraffin hydrocarbon which was used to supplement *iso*-octane in the preparation of aviation blends.

The ammonia production was 200,000 tons per year. This was achieved with two converters.

Glycerine was made at Heiderbrech from propylene made by dehydrogenation of the propyl alcohol from the higher alcohol synthesis. A production of 6,000 tons per year was planned but rather less than 2,000 tons per year was achieved.

There was also a plant at Heiderbrech for the oxidation of paraffin wax to fatty acids used for soap. A production of 20,000 tons per year was achieved.

17,000 tons of salt were electrolyzed to give chlorine for the glycerine process and caustic soda.

It was planned to make lubricating oil by polymerization of ethylene obtained partly from Linde fractionation of coke oven gas and partly by cracking ethane pipelined from Blechhammer. A production of 22,000 tons per year was planned. The plant was actually erected but never got into operation.

20,000 tons per year of *Kaurit* (urea formaldehyde glue for plywood) was made at Heiderbrech using urea imported from Oppau.

Hydrogen Peroxide.—Hydrogen peroxide has received far wider attention in Germany

during the last eight years than anywhere else in the world, both as regards the investigation of its properties and applications and the development of really large-scale methods of production. The incentive came from the idea of using peroxide as a source of oxygen for submarine motors and torpedoes and as a source of power for the propulsion of aircraft and projectiles. The new developments resulting from the above incentive were: (1) the production of 80-85 per cent. hydrogen peroxide of exceptional purity and good stability; (2) planned production of hydrogen peroxide in hitherto undreamed of quantities, and (3) production of hydrogen peroxide by new methods which could be rapidly adapted to large-scale production.

The *Elektrochemische Werke*, Munchen A. G., Hollriegelskreuth, developed the main process used in Germany for the conversion of 30-35 per cent. peroxide to 80-85 per cent. The material from any of the persulphate processes was not pure enough for direct concentration and was, therefore, distilled in a bulk evaporator, the vapour being evaporated in a normal packed fractionating column to give high strength material. In some cases, the material was distilled a second time for even greater purity. The *Elchemie* factory at Kufstein had developed a process for the concentration of 30 per cent. peroxide using climbing film evaporators for the first stage (distillation to give pure H_2O_2 liquid) and climbing film concentrators for the second stage (concentration to 80-85 per cent).

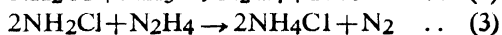
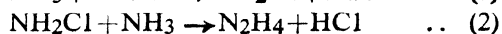
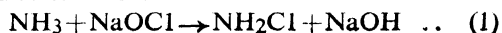
High purity was essential chiefly to ensure stability. It was also necessary in cases where peroxide was to be used in conjunction with a solid catalyst. The product was stabilized by pyrophosphate and 8-hydroxy-quinoline and the results were equal to normal 30 per cent. peroxide stabilities. In large aluminium containers, the loss in 12 months was as low as 2 per cent. It was dangerous to concentrate beyond 85 per cent., as it caused "flashing" in the still and consequent danger of cracked stills. It was, however, considered possible to attain 90 per cent. or even higher strength in the climbing film type plant. Some 15,650 tons of 85 per cent. peroxide were being produced in a year.

In spite of great research activity throughout Germany, no direct synthesis method was put into operation. Great progress, however, appears to have been made in the development of the electric discharge

process. But owing to high consumption of electricity, the method was considered to be uneconomical. The method had certain advantages when super-high purity was demanded.

An autoxidation process using ethyl anthraquinone had been worked out by I.G. at Ludwigshafen. The I.G. pilot plant had a capacity of 5 tons of 20 per cent. hydrogen peroxide per day. In this process there was the risk of production of explosive organic per-compounds.

Hydrazine Hydrate.—The process employed in the works of the *Chemische Fabrik*, a subsidiary company of *Elektrochemische Werke*, Munchen, was based on the well-known Raschig reaction between sodium hypochlorite and ammonia, and involves three chemical reactions:



Reaction (1) proceeds rapidly with good yield, but reaction (2) is slow, and the side reaction (3) removes both the chloramine and hydrazine. Reaction (3) is extraordinarily accelerated by traces of iron and copper ions, so that it is usual to add glue to remove these ions from solution. Excess of ammonia favours reaction (2) relative to (3). In the Gersthofen process, a tenfold excess of ammonia and an elevated temperature of 160° C. were employed. To keep the ammonia in solution, a pressure of 30 atm. was necessary, and under these conditions, the reaction was complete in 1.0—1.5 seconds. The hydrazine hydrate is worked up by direct rectification without separating hydrazine sulphate.

Hydrogen peroxide is most efficiently utilized for propulsive purposes when it reacts directly with another substance. Its simple decomposition by catalysis is wasteful because it discards oxygen that might be used to better purposes. A satisfactory direct interaction of hydrogen peroxide with such another substance (or substances) is not easy to obtain. The Germans have succeeded in solving this problem practically, by the use of hydrazine hydrate as an adjunct to the combustion process.

Hydrazine hydrate rather than hydrazine, is used because the hydrate is much easier to make. The presence of the one molecule of water of hydration is not objectionable; in fact, recently the Germans have deliber-

ately added water to C-Stoff (hydrazine hydrate, catalyst, methyl alcohol) in order to save hydrazine hydrate.

Although hydrazine hydrate reacts readily with hydrogen peroxide, ignition delays sometimes occur. These ignition delays result in explosions, probably because of the accumulation of reactants within the combustion chamber. For this reason, a catalyst is always employed to reduce the ignition delay. The catalyst used operationally are copper salts; many substances, including sodium nitroprusside, $\text{Na}_2\text{Fe}(\text{NO})(\text{CN})_5$, have been tried. Hydrazine hydrate itself is stable indefinitely and may be stored in the ordinary metal containers, but the presence of the catalyst in C-Stoff gives rise to storage problems.

Hydrazine hydrate is a powerful reducing agent and, therefore, tends to change copper salts into metallic copper, which would precipitate out of solution causing the catalytic activity of the C-Stoff to be lost. (Explosions have occurred operationally for this reason.) It consequently becomes necessary to tie up the copper as a complex ion as in $\text{K}_3\text{Cu}(\text{CN})_4$, potassium cuprocyanide, electroplating salt, which is the catalyst substance dissolved (about 1.7 grams per litre C-Stoff). The aluminium containers in which C-Stoff is stored must be properly passivated, or copper will be precipitated electrochemically by the action of aluminium. In the isolated case where an explosion occurred with C-Stoff, otherwise properly handled, such a loss of passivity was postulated as the cause.

Calcium and Sodium Permanganate—Sodium and calcium permanganates were manufactured from potassium permanganate by an ion-exchange process. Potassium permanganate was passed through sodium or calcium zeolite giving the required permanganate. The zeolite was regenerated with sodium or calcium chloride. The zeolite employed was a product of *Permutit A. G., Berlin*, known as *Permutit G.* (used for the decomposition of hydrogen peroxide).

Shale Oil.—In Wurtemberg, information was obtained on the only process of its kind for underground mining and underground distillation of shale. The overground equipment consists of gas recovery plant from which 10 per cent. of the oil produced could be recovered. The plant had a maximum capacity of 7 tons of oil per day. In the *Portland Zement Werke, Dotternhausen*, a

plant for the continuous production of oil from Wurtemberg shale was in operation. The plant consisted of eight full-sized retorts, each capable of handling 45-50 tons of shale per day. The yield of gas was 80 c.meters per ton of shale. The oil was extracted by superheated steam at 700-800° C. Benzine, oil and ammonium carbonate were recovered after distillation. The residue was used for the manufacture of portland cement. An experimental unit for the extraction of oil by the use of molten aluminium was almost completed. The plant had a capacity of 240 tons of shale per day and would require 50 tons of aluminium.

A new iron catalyst had been developed for the Fisher-Tropsch Synthesis by the *Matallgesellschaft A. G.*

Liquid Oxygen.—The plant at the *Experiment Station, Oberadaracht*, contained four complete units using 5-stage compressors capable of producing 400,000—500,000 kg. of liquid oxygen per month.

Synthetic Rubber

Intelligence of prime importance concerning the German synthetic rubber industry, obtained from Schkopau and Huls, includes the following:—

- (1) A new catalyst for the more efficient production of styrene, one of the two important intermediate materials required in the production of synthetic rubber.
- (2) Full information on "Plastikotar 32", a softener for *Buna S* which greatly improves the quality of synthetic rubber tyres and aids in the technique of production.
- (3) A continuous process for producing *Buna 85*, a valuable hard rubber product with a high softening point which is especially resistant to extreme temperatures.
- (4) A new method for concentrating synthetic rubber latex for use in all dipped products, general surgical items and prophylactics.
- (5) Complete formulæ and manufacturing techniques for all German synthetic rubber together with data on the raw materials required for manufacture.
- (6) Intelligence concerning by-products including a substitute for glycerine used in the manufacture of nitroglycerine. The substitute, nitrated di-glycol, leads to a range of propel-

lants which can be produced despite shortage of glycerine.

- (7) A compound *Alumina* which can be used as a substitute for carbon-black in tyre production.

The results of the investigation of the German synthetic rubber industry including the *Koresine* tacking process obtained from Ludwigshafen have already been introduced into the American industry.

The *Record Rubber Works* at Schweifus, Brandenburg, was engaged in the manufacture of rubber and foam-like resins. The material made from either synthetic rubber or *Igetit*—a polyvinyl chloride product, had a sp. gr. as low as 0.02 or even less, i.e. 1/15 that of cork, and possessed remarkable insulating properties against sound and cold. It can be produced in different grades of softness ranging from a soft and flexible grade similar to sponge rubber, to a hard and wood-like one. It was being used by the Navy in large quantities as filling material for rafts, rubber boats, life-belt and other life-saving devices. It was also used for puncture-proof tyres. It is known that many planes and their pilots are lost due to capsizing of the plane when landing due to a flat tyre. This danger could be eliminated when the machines were fitted with puncture-proof tyres. This sponge-plastic was designed for use in Speer Brechess to give added buoyancy in the event of large compartments being holed. A soft spongy form is used for packing delicate parts, e.g., radio valves, and a soft touch variety for clothing swimming saboteurs. A covering for conning towers of U-boats was made from this material. It is understood that this serves as a heat insulant against infra-red detection. The material had numerous other uses, and a great variety of mouldings, sheets, and other articles were being manufactured. The process employed in its production was as follows:—

When polyvinyl chloride was used, the moulding powder was mixed with a plasticizer (tricresolphosphate). Then a nitrogen containing material called Porophor obtained from *I. G. Farben Industrie* was mixed with the plasticized resin. The material was heated in a high pressure mould to approximately 150° C., at which temperature the nitrogen in the Porophor is released in the form of extremely small bubbles while the mould pressure is maintained at 200 kg. per sq. cm. or approximately 2,800 lbs. per

sq. inch. The mould was opened to room temperature and the plastic glass allowed to expand to equilibrium pressure. The resulting plastic is then a mass of individual nitrogen bubbles extremely small in size, each bubble being completely closed. The specific gravity of the mass can be made as light as 0.03.

This material is capable of withstanding incendiary bullets without burning and has been adopted by the German Navy and Air Forces as filling material for life rafts and vests. A plant to make this material was projected in Thuringia but the war came too close to allow completion of the programme.

Bicycle tyres have been filled with this material and were found to have been satisfactory after having been fired upon with S.A.A.

The material was also moulded to fit into auto tyres and found to be suitable. *Buna S* could be treated in a similar manner. Gasified *Buna* was found to be better suited for auto tyres than the PVC (Polyvinyl chloride) product. Tyres made in this manner were satisfactory as puncture proof for 30,000 kilometres, even after fired upon with machine-gun fire.

The *I.G. Farbenindustrie A.G.* had made arrangements with a large number of professors and others in German universities for co-operative research on various subjects, especially on rubber and other polymerization and condensation products. The improvement of properties of high-polymer halogenated hydrocarbons and high-polymer esters by treatment with polyacrylene imine received special attention. The *Leuna Werke*, a subsidiary of the *I.G. Farben Industrie*, had several departments for control and expansion of production of certain key materials including plastics and *ersatz* fuels. All synthetic rubber research was centralized at Leverkusen under the direction of Dr. Konrad, in whose laboratories, researches on polymerization for all types of *Buna* rubbers, including the use of monomers, research on rubber compounding and tyre building, development of new physical and chemical tests for *Buna* rubbers, were in progress.

Other items of war-time research in synthetic plastics include plastics from pentaerythritol (*Deutsche Gold and Silberwerke, Konstanz*); a new variety of nylon called *Furon* (*Phrix, Hamburg*) (Adipic acid made by the nitric acid oxidation of cyclohexanol was employed for the manufacture of nylon.

Tetramethylene diamine and cuprolactam are also required for the production of nylon); *Buna S* was regarded as an excellent substitute for leather (*Buna Werke, Schkopau*). At the *I.G. Bunawerke, Schkopau*, styrene was being produced by the use of a new type of catalyst. The construction of the furnace, and the production of 99 per cent. plus monomer are of special interest.

Paper impregnated with phenol formaldehyde resin was employed as an adhesive in the manufacture of plywood.

The *I.G.* plant at Bitterfeld South, produced 1,500—1,600 tons of polyvinyl chloride per month. The polymerization was carried out in 15 batch autoclaves and dried in two spray driers. The product was employed for insulating cables, production of pipes and valves, and for working up into lacquers.

For the production of styrene required for *Buna*, the starting material, ethylene, was obtained by the dehydrogenation of ethane. The process was inefficient. A process for thermal conversion of ethane to ethylene by indirect heating and for the arc cracking of gaseous hydrocarbons under vacuum had been worked out. A catalytic process for the hydrogenation of acetylene to ethylene had been developed.

Methods of spinning chlorinated polyvinyl chloride (PVC) and of extruding unchlorinated PVC to make bristles and artificial bamboo had been developed. Virilene chloride manufacture had not advanced in Germany.

Fibres were produced in large quantities from straw and pine wood. Complete technical details were secured.

Metallurgy

Research projects included the study of the effect of manganese sulphide distribution in cast iron on corrosion resistance, new alloys of aluminium and magnesium, particularly alloys with zinc, and their corrosion resistance. A substitute alloy consisting of noble metals had been developed to replace platinum, which was in short supply, for use as a catalyst in chemical reactions.

A bearing alloy, *gittemetal* (babbit metal), mainly of lead and zinc, was being produced with a view to conserve tin. To economize non-ferrous metals, various techniques had been developed for securing a thin working surface of non-ferrous material to a common steel backing. Such surfacing was being given not only to bearings but also to gears;

in this case, a layer of phosphor bronze was applied to the profile of the teeth. Considerable research had been expended in developing processes to overcome shortage of raw materials such as copper and tin.

Considerable work had been carried out on powder metallurgy.

Regarding the metallurgy of aluminium and magnesium, no new development had been made. Magnesium was being manufactured by the electrolytic process. For the recovery of aluminium from scrap, a flux composed of 1:1 sodium and potassium chloride with 5 to 10 per cent. calcium fluoride was used. A process for working up scrap to obtain aluminium consisted in treating the scrap with mercury under pressure at a temperature of about 600° C. to form an amalgam. Some common impurities like Cr, Mg, Sn, Pb, and Zn, are soluble in mercury, whilst others like Si, Fe, Mn, Ti, Va, are insoluble and can be removed by filtration at ordinary temperatures through porous chamette containing approximately 40 per cent. aluminium and 60 per cent. silica. The mercury soluble metals were removed substantially from the first amalgam by treatment in a second autoclave with excess of mercury, but some copper always remained in the final product. The process is considered to be more economical than the normal methods.

Aluminium powder was extensively employed in the manufacture of flame throwers, which were made by mixing aluminium powder of 200 μ particle size with oil in 20:30 proportion. The ingredients were mixed 12 hours before use. The resulting fuel gives a range of 42 metres, as compared with 25 metres for oil alone, when fired from an Einstoss flame thrower and the heat of the flame was 1,600° C., and in addition to its burning and demolition properties, it also blinded the onlookers with its very bright white flame. Magnesium could not be successfully employed, as it was liable to spontaneous ignition when ground to very fine powder.

Food Products

The dehydration processes employed for fruits and vegetables were very crude compared with those employed in America and in the United Kingdom.

For the production of food yeast from sulphite waste liquors from rayon factories, the *I.G. Farbenindustrie* had developed a process which was quite distinct from the one

used in the U.K. The organism employed was *Candida arborea*, not *Torula utilis*. This organism withstands a higher temperature (40° C.) than *Torula*.

Torula utilis was also employed in some of the production units. Thus at the *Brennerei und Chemische Werke, Tornish, G.m.b.H.*, 6-7 tons of dried yeast were being produced daily. The medium was prepared from soft wood saw dust. Molasses was also employed.

Some of the more important developments in Germany in the paper industry during the war period were:

The universal manufacture of alcohol from waste sulphite liquors at all sulphite mills.

The very large production of yeast of approximately 50 per cent. protein content at all sulphite mills.

The development of the Swedish Romain process in which the waste from either alcohol or yeast manufacture are evaporated and burned in furnaces of the Tomlinson type, in order to reduce stream pollution.

Development of a high kraft pulp of 94-95 per cent. α -cellulose to be used in a mixture with 50 per cent. linen for cigarette paper.

Development of Schongren process which is a modified form of the Thorn barking system, where the barking is done under water thereby reducing power consumption and producing clean wood.

A process for the reduction of cellulose at high pressure at a temperature of 160° C., using hydrogen as a reducing agent to produce a mixture of glycerine and glycol.

The pre-hydrolysis of beech wood with 2.5 per cent. sulphuric acid, fermenting of the waste liquors to produce yeast, and cooking of the wood residue by the kraft process to produce a pulp of 96 per cent. α -cellulose content.

The nitric acid pulping of beech wood practised at Wolfon near Berlin was successful for producing a pulp of 98 per cent. α -cellulose content, especially suited for the production of acetate silk. To make the process economical, it is necessary to have cheap nitric acid which for this particular plant comes as waste product from a dyestuff plant.

The experimental work on iron removal from water by base interchange using lignin was extremely promising.

Germany required much poplar for pulp, veneer, matches, etc. They had been gratified in developing a hybrid poplar which analysed up to 50 per cent. α -cellulose and which could grow to 8' trees in eight to ten years.

This work was so promising that the German Government had heavily subsidized the research.

During the war period, binder twine made from wet strength treated sulphite paper had replaced sisal.

It was found in Germany that unbleached sulphite pulp running 88-90 per cent. α -cellulose content was suitable for the production of nitrocellulose to be used as an explosive. Further, such pulp was more stable than one made from bleached sulphite pulp of 94 per cent. α -cellulose content and practically nitrocellulose explosives during the war period were made from unbleached pulp.

Water-resistant Varnishes.—The crude raw material consisting of sulphite pulp residues was decomposed with sulphuric acid, washed and thoroughly dried in a vacuum. The product contained about 50 per cent. resin acids, largely phenanthrene derivatives with about 20 carbon atoms. This was known as *Rohtalloe*. By centrifuging, a pale yellow solid containing 90 per cent. abietic acid was obtained, but only in small sized plant.

The rohtalloe is distilled at about 280° C. and 12 mm. giving 80 per cent. *Talloe* and 20 per cent. sulphate pitch which is used for waterproofing felt, etc. A small light fraction of no special interest was also obtained.

The talloe was esterified with glycerin, or glycerin substitute (apparently a mixture of glycerin, glycol and other substances known as *oxydpech* obtained from I.G.). Pentaerythritol from I.G. was also being used with success. The product gave rather slowly drying and waterproof films.

Judging from experience with lac, these films, though good in some respects, may fail in others. They can be made in very many varieties. The acid value of the product is usually about 6.

Other Researches

A siliceous varnish was being employed as a substitute for gelatin in culture media for bacteriological work.

Glycerine distearate was used as an emulsifying agent for the manufacture of margarine.

The chemistry of *Expansin* was investigated at the Netherlands Institute of Nutrition. *Expansin* is the extract of *Penicillium expansum*, produced at the Botanisch Laboratorium, Utrecht. Prof. Jansen had concentrated the *patulin* principle of the extract, but had not been able to isolate the true active principle. 80' gallons of the extract per week was being produced. Much research

was also being done on the anti-biotic factors of other species of *penicillium* and of other fungi. Expansin is very efficient against lupus, tricho and expidermophytotic infections of the skin. There is also reason to believe that it is effective against tubercular infections. The extract is too toxic for intravenous use.

In the Chemical Research Laboratory of Dr. Bruno Bottcher, Kronach, Bavaria, investigations were on hand for the purification and concentration of penicillin by the electro-osmotic diaphragm process. Penicillin had been shipped in thermos jugs from Schering in Berlin. The project was under way for six months and was thought by Bottcher to have great promise.

In the Utrecht Laboratory of Organic Chemistry, much research has been carried out on cancer. A new theory, based on the abnormal acculation of *d*-glutamic acid found in the cancer tissue had been developed. Using the heavy isotope of hydrogen, the relation of cancer to *d*-glutamic acid had been established.

Considerable research had been carried out on *Lupolon*, a polyethylene, *Lauseto*, a most effective insecticide suitable for impregnating textiles, non-toxic and resistant to washing; *Lauseto-neu*, especially effective against bed-bugs; new fungicides, for impregnating textiles, leather and wood; *Sontochin*, an anti-malarial; heparin substitutes; use of dixoy-coumarin in post-operational shock; synthetic blood plasma, *Periston*; insecticide with the formula

$\text{Cl} \begin{array}{c} \diagup \quad \diagdown \\ \diagdown \quad \diagup \end{array} \text{SO}_2\text{CH}_2\text{Cl}$, effective against mosquitoes; *Sympatol*, said to be an improvement on adrenaline; three sulphur drugs—Pyralin, Globusid and Albusid—of which globusid is new; and *DDT*.

In the Chemical Research Laboratory of Dr. Bruno Bottcher, Kronach, Bavaria, a successful method had been worked out for the purification of adrenochrome. It is known that while adrenaline raises the blood pressure, adrenochrome lowers it. Adrenaline is soluble in acidified methyl alcohol and when oxidized with silver oxide, Ag_2O , a precipitate of adrenochrome is obtained. A solution of *l*-adrenaline (1/10 mol.) in 500 cc. of methyl alcohol-formic acid (2 cc. formic acid per 100 cc. of methyl alcohol) is mixed with $3\frac{1}{10}$ mol. of Ag_2O and shaken for 1 min. The oxidation

temperature is maintained between 30°-40° C. The excess of Ag_2O is immediately filtered off from the reaction mixture by suction, and washed with 100 cc. of methyl alcohol (100 cc.). The filtrate is cooled to -20° C. for not more than 1 hr., and the adrenochrome (m.p. 130° C.) which crystallizes out is separated by filtration. A yield of 50 per cent. of theory is obtained.

Adrenochrome has been used in the treatment of diabetes. It is not a substitute for insulin but an adjunct to it. 2 grs. given in small doses by mouth in solution at frequent intervals, were sufficient to treat one diabetic patient for one year. When adrenochrome is used, less than one-third as much insulin is required for the treatment.

In the field of fire extinguishers, an effective air-foam solution had been developed at the *Chemische Fabrik* von Dr. Richard Sthamer, Hamburg. It was prepared by digesting hoof and horn meal of particle size about 2 mm. with calcium oxide in a pressure cooker at 120°-130° C. After $\frac{3}{4}$ -1 $\frac{1}{4}$ hr. cooking, depending on the raw material, the insoluble material was filtered and the filtrate neutralized with sulphuric acid to a pH. of about 5.8. It was again filtered and the filtrate concentrated to a sp. gr. of 1.14-1.15 at the boiling point. Ferrous sulphate—5.75 kg. for 1,000 litres of solution, and sodium bezoate—11.25 kg. for 1,000 litres of solution, were added, the solution cooled and then filtered. 6-8 per cent. of the solution was added to water before incorporation of air to create the foam. It may be mentioned in this connection, that an identical process had been worked out in the Laboratories of the Council of Scientific and Industrial Research, Delhi, for manufacturing air-foam solution, which has been successfully employed in India and elsewhere for fire fighting.

Glass wool, glass wool cloth, glass wool blankets (for locomotive insulation), etc., had been developed for heat insulation purposes.

A new process for producing carbon black from natural gas, by exploding a carefully controlled mixture of methane and pure oxygen, had been developed.

The possibility of using urea as a source of nitrogen in feeding stuffs for animals was investigated.

A foam process was employed for spreading urea resin glue in plywood manufacture, and logs were steamed prior to the cutting of veneers.

CULTIVATION AND SYSTEMATIC STUDY OF THE TUNG OIL YIELDING TREES IN INDIA*

By K. BISWAS

(Royal Botanic Garden, Calcutta)

Early History

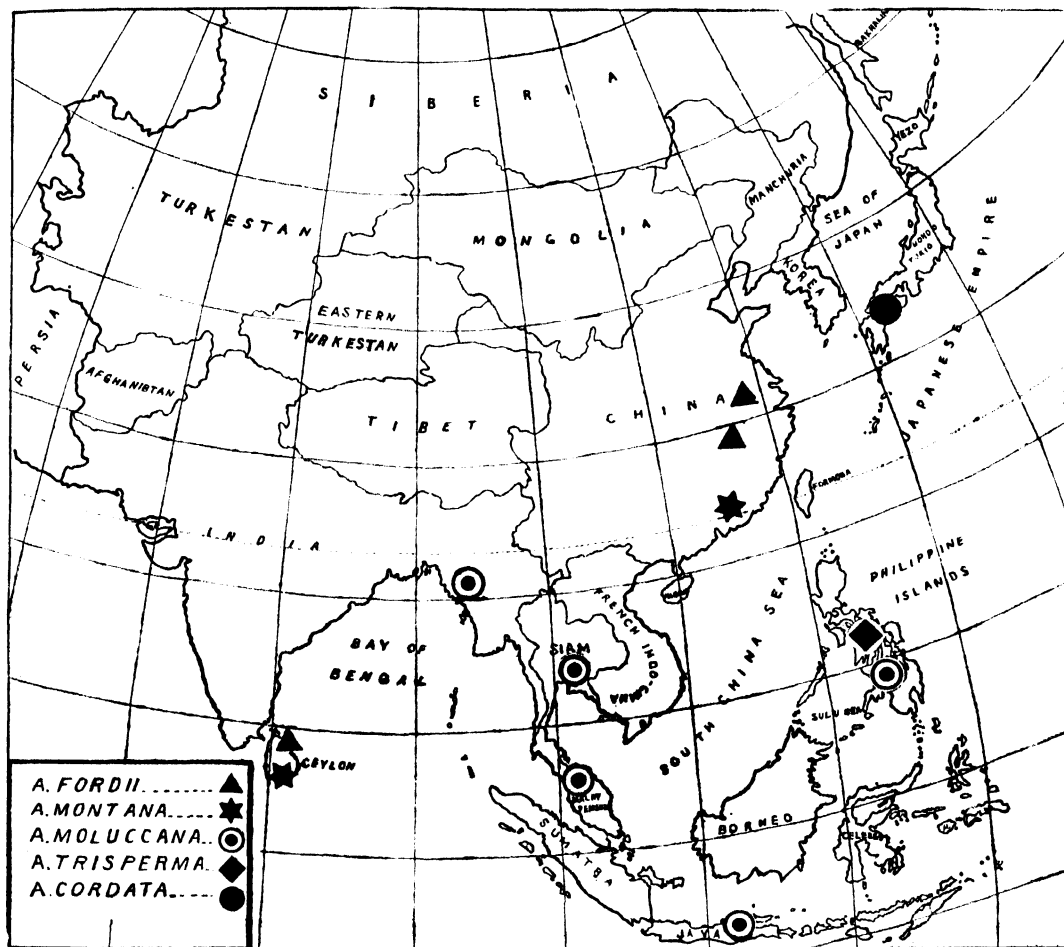
THE true tung oil is the Chinese wood oil of commerce. It is extracted by crushing the kernel of the seeds of mainly two species—*Aleurites Fordii* and *Aleurites montana*, belonging to the family of Euphorbiaceæ. The oil extracted from *A. Fordii* is known as *tung-yu* and from *A. montana* is *mu-yu* in Chinese. All the five species of the genus *Aleurites* known to science are trees of Asiatic and Malaysian origin (cf. Map 1). All of them are of economic importance and the seeds yield a fixed oil. The trees having more or less heart shaped leaves are commonly *tung* in China. The shells of the ripe fruits of *Aleurites* sp. are as hard as wood and on account of this hard-woody pericarp of the fruit, it is popularly known as Wood-oil Tree, Chinese *Mu-yu-shu*.

Various uses of tung oil were known to the Chinese from ancient times. During the Hun period, as far back as A.D. 220, the famous Chinese black ink was manufactured by burning the tung oil. For centuries, the oil had been utilized in China as a drying oil for various purposes such as polishing furniture, painting woodwork and metals, caulking boats and junks, water-proofing umbrellas, manufacturing linoleum and oil-cloth, lacquering, varnishing and so on. In the last decade of the thirteenth century Marco Polo, the famous Venetian, reported on the use of the Chinese wood oil as follows:—"They take some lime and chopped hemp, and these they knead together with a certain wood oil; and when the three are thoroughly amalgamated, they hold like any glue, and with this mixture they do pay their ships." The value of the wood-oil was known to the West as early as A.D. 1516, when the Portuguese (Capt. Raphael Pestrello) started sea trade between China and Europe. The commercial value of the Chinese wood oil as an important ingredient of varnish and paint products

was realized by the Americans and the Europeans since the early part of the nineteenth century. From 1918 onwards the United States of America, Great Britain, Denmark, Germany, Holland, France, Belgium, Italy, Norway, Canada, Australia, New Zealand, Africa (Kenya), Madagascar, India, Ceylon, Burma, Malaya, Java, Fiji, West Indian Islands and a few other countries evinced considerable interest in the unique drying and water-resisting properties of the tung oil. The high standard and quality of the tung oil as compared with the linseed oil has been noted by Jordan† in the following words:—"The principal use, of course, is in varnish and paint products, and during the years 1900-10, varnish manufacturers, particularly in England, were gradually becoming used to the idea that tung oil was likely to be used. It was unfortunate, perhaps inevitable, that the pioneers should have offered this new oil as a substitute for linseed oil. The word *substitute* has a flavour of inferiority, of something commanding a lower price; but gradually the merits of the oil began to be recognized. Tung oil was a substitute for linseed oil in the sense that it could be processed by the established methods of processing linseed oil in varnish manufacture. Nor were the products ever the same in their properties. Indeed in many respects, tung oil is unique among the commercial drying oils available; there are varnishes in regular demand to-day in which tung oil alone can fulfil the requirements." Laurie and Sen Gupta mention from a report in the *New York Times* that Harvey G. Kittredge of Dayton, Chicago, was granted a patent to a new rubber substitute made from tung oil. The inventor asserted that in some features, the new rubber substitute was superior to the natural product. Many acids and alkalies do not affect it. Oil and greases do not attack it. The tung oil rubber is already finding widespread use as a substitute for natural rubber in paints and varnishes, and as a coating for textile materials. It can be vulcanized

* Abridged from a memoir on the subject by Dr. K. Biswas. It is understood that the memoir will be published in *extenso* elsewhere.

† Jordan—*Empire Production of Oil*, 1935.



Map 1—Distribution of Tung oil yielding trees in the Eastern Asia.

like natural rubber with sulphur, yet the vulcanized product contains no free sulphur which is considered objectionable in rubber for certain uses. Tung oil is extensively used in the manufacture of electrical insulating varnishes and for treating aeroplane fabrics. The oil is much used also in the automobile and other industries. New industrial uses for this oil are likely to be discovered by further researches. The bright future for tung oil as an important article of commerce is thus fully assured.

China is the chief source of tung oil and up to 1935 about 90 per cent. of the demand was met from China alone. Table I indicates the extent of the Chinese supply to the world market from 1918-34. The American product came into the market in 1934 but the

supply is not yet quite steady or sufficient to meet fully her own internal consumption.

The leading industrialists in the U.S.A. and Great Britain foresaw the risk in depending solely on one country for the supply of tung oil, whose growing demand as an essential raw product for so many industries, was more and more felt since the last Great War. It was found that between 1920 and 1930, there was considerable deterioration in the quality of supplies from China. Solid particles were noticed in the oil either in suspension or as sediment, and adulteration with the oils of tea seed and soya bean was detected. There were no organized plantations in China nor was there an indication of any serious attempt to cultivate the two species of tung oil plants systematically on modern

TABLE I. Exports from China and their Destinations.

	Exported to	(Long Tons.)													
		1918	1920	1922	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
1.	Australia and New Zealand				72	1,728	88	3	61	105	115	130	193	220	244
2.	Belgium				157	159	198	205	136	176	215	216	205	401	376
3.	Canada				515	156	2	..	..	..	..	..	3	62	..
4.	Denmark				249	156	144	202	333	288	429	709	641	644	743
5.	France				978	847	1,193	815	1,024	1,491	1,833	950	1,028	2,210	3,135
6.	Germany				4,719	3,778	2,738	3,228	2,553	1,425	2,147	1,640	1,151	1,415	2,214
7.	Great Britain	1,765	1,379	1,384	3,179	2,297	2,896	2,660	5,945	5,002	5,608	5,930	5,121	4,516	3,081
8.	Holland				474	619	927	3,429	1,537	1,973	2,191	2,706	3,533	4,049	3,057
9.	Hongkong				4,402	1,728	3,186	7,957	8,252	7,433	3,229	4,975	4,904	6,675	8,518
10.	Italy				365	265	225	327	335	403	377	328	236	260	329
11.	Japan				708	358	457	391	473	1,176	641	510	407	584	914
12.	Norway				..	42,029	..	..	..	..	..	..	..	..	544
13.	Other countries				786	983	427	358	487	385	579	621	840	846	707
14.	United States	14,311	22,616	36,747	37,324	42,029	32,144	34,066	44,062	43,765	52,024	32,714	29,511	52,327	40,391
	Total	16,076	23,695	38,131	53,928	97,132	44,625	53,641	65,198	63,622	70,388	51,429	47,773	74,209	64,253

The Hongkong figures are really additional export, probably mostly to U.S.A. and Great Britain.

scientific lines. The fruits were collected from the trees growing in their natural habitats on rocky hillsides, and the oil was extracted by crude methods. The prospect of any extensive cultivation of the trees in China was poor, as due to the increasing density of population, land was needed more for the cultivation of cereals and edible crops than for the plantation of tung oil yielding trees. Finally, the war-clouds burst over China, and transport of tung oil from China to other countries became more and more difficult. The export of the oil ultimately ceased altogether.

These facts were duly considered by leading industrialists in America and Great Britain. The need for relieving China, the only source of tung oil, was felt by the commercial, agricultural and industrial organizations, particularly in America, which was importing 40,000 tons of tung oil per annum (more than ten times the quantity imported by Great Britain up to about twenty years ago). It was but natural that U.S.A. took the initiative to grow tung oil trees in their soil on a commercial scale. The recent war proved that their action was wise. The cultivation of tung oil trees on scientific lines was undertaken by the American Tung Oil Corporation with the assistance of the Department of Commerce.

Cultivation in U.S.A. and in Countries other than India

A. Fordii was first planted in the U.S.A. at Biloxi in 1904. The tree which was introduced there for the first time still stands as a living monument commemorating the introduction of a valuable agricultural product which brought so much prosperity to the Southern States bordering the Gulf of Mexico. The soil in some of the Southern States, such as Florida, Georgia, Mississippi, was suitable for the cultivation of *Aleurites fordii*, and in 1930-31 there were about 12,000 acres under cultivation in the three States. It has, however, been estimated that 100,000 acres would be required for meeting the American demand. M. B. Smiths in his article entitled *Tung oil: A new plantation crop*, gives a brief resume of the experiments done on the two species — *A. fordii* and *A. montana*:

"The harvesting of tung nuts in the South Mississippi tung tree belt, where more trees are planted than in any other section of the United States, is now under way and will

continue for several weeks. The crop this year is the largest since the industry was established with an estimated value of \$1,000,000. The tung nuts begin maturing in October. When ripe they drop from the trees, harvesters pick them up, place them in sacks and trucks, gather up the sacks and take them to crushing plants. These mills, most of which are located in Picayune, Miss., in the heart of the tung tree orchard belt, began operation as soon as the first nuts dropped from the trees. Upon reaching the mill the nuts are fed into machines that remove the hull and pass to the crushing machines that extract the oil. The oil, because of the present disturbed situation in the Orient, is commanding the highest price in history. Nothing goes to waste in the processing of the nuts. After the oil is extracted, the meal and hulls are used as fertilizer and tung meal fertilizer is valued from \$15 to \$20 per ton. The progress of tung plantings in Mississippi resulted from the growing realization of the need for profitable utilization of cut over timber lands and the desire of the lumber companies to diversify their activities. Some lumber corporations have gone into the tung business on a mass production basis, setting out many thousand acres of tung trees on cut over land. In Mississippi, the concept of tung tree planting differs materially from that prevailing in other regions. The setting out of extensive individual groves and the attaining low planting and cultivation are undertaken. Minimum cultivation and fertilization were contemplated originally by reason of the natural richness of the soil but this idea has been abandoned."

The *American Tung Oil Corporation* did not lose sight of the possibility of manufacturing better quality oil by using modern machinery. In fact, the tung oil mill, with a capacity of extracting 50 galls. of oil from 1,000 lbs. of seeds per hour, was put under operation in January, 1929. This marked a great stride in the tung-oil industry which has flourished in America on a commercial basis from 1930 onwards. The American oil is free from impurities and is superior to the Chinese oil.

From 1927 onwards, there has been an increasing demand for encouraging the Empire production of tung oil by the *Imperial Institute Advisory Committee on Oils and Oilseeds*, and such other institutions as the *Royal Botanic Garden, Kew*, and the *Research Association of British*

Paint, Colour and Varnish Manufacturers. They, particularly the *Royal Botanic Garden, Kew*, took active interest in the distribution of 4 tons of seeds of *A. Fordii*, and 700 lbs. of *A. montana* received from China and Florida to different parts of the Empire and encouraged its cultivation on a wide scale, specially in India and Africa. Experimental cultivation of tung oil trees started in India, Burma, Ceylon and Africa in the beginning of the second quarter of the present century.

Experimental cultivation has been undertaken in Cyprus, Palestine, Iraq, British Honduras, Leeward Islands, Jamaica and other West Indian Islands; South Africa and East Africa, mainly Kenya and parts of Tanganyika, Nyasaland, Rhodesia, Sudan, Nigeria, Algiers, Morocco, Madagascar, Mauritius, Seychelles, West Africa, Sierra Leone, St. Helena, India, Ceylon, Burma, Hongkong, Malaya, New Guinea, New Zealand, Fiji and Australia. In India seeds were imported or received by different institutions direct from Kew, China (Nanking University), Hongkong and Florida. The *Royal Botanic Garden, Calcutta*, received half a ton of seeds and took charge of its distribution over different parts of India. During the last twenty years valuable data have been obtained from the results of experimental cultivation in different parts of India and Burma.

Experimental cultivation in Kenya was established in 1922 from the seeds obtained from Hankow (China) and Hongkong between elevations 5,000' and 8,000'. Both *A. Fordii* and *A. montana* were tried. There was considerable variation in the growth of the trees and some of them are still alive. The results so far obtained cannot be considered satisfactory, but they are more promising than in Malaya. The variation in the results may be due to variations in the quality and viability of the seeds and the nature of local climatic and edaphic conditions. The results of planting operations in other parts of South and East Africa and Asia Minor and other areas are in many cases negative and too insignificant to deserve mention. The failure is due mainly to the unfavourable climatic and edaphic conditions prevailing in these regions.

Experimental cultivation of both *A. Fordii* and *A. montana* in Malaysia (Malaya-Serdong, Kuala Lumpur, Java, Malacca) was started in 1914 under the auspices of the Department

of Agriculture, Straits Settlement and Federated Malay States. The results obtained show that the trees grow well at the early stage, but after attaining a height of 5' to 6' become stunted and gradually deteriorate. The cultivation of the true tung oil plants in the Malayan region is, therefore, not likely to be a success. The allied species might be tried. In fact, these allied species *A.cordata*, *A.moluceana* and *A.Trisperma* are common in the tropical regions of Eastern Asia. The oil from these species, although not of so high a standard as that from *A.Fordii*, is yet useful for several purposes.

Experimental plantations of *A.Fordii* were started in Australia and New Zealand as early as 1913. The cultivation was mainly confined to New South Wales, under the expert guidance of the *Botanic Gardens, Singapore*. Cultivation has been earnestly undertaken by the *Queensland Forests Ltd.* in North Queensland, and the syndicate of local agriculturists in New Zealand has also taken up plantation operation over 2,000 acres in Helensville district. These plantations are on a scientific basis and the results obtained are quite promising. The quality of the oil, obtained from the seeds of *A.Fordii* grown in Kenya, Malaya, Australia and other places are more or less of the same standard as that of the genuine Chinese wood oil, i.e., oil extracted from the seeds of the *A.Fordii*, grown in their natural habitat in China.

Laudable attempts have been made in different parts of Ceylon and Burma in the experimental cultivation of *A.Fordii* and *A.montana* with a view to extending it on a commercial scale. In Ceylon, the Department of Agriculture first introduced *Aleurites Fordii* with seeds received from the *Botanic Garden, Hongkong*, in 1917, and subsequently *A.montana* in 1918. The experimental planting operation was undertaken by the *Royal Botanic Garden, Peradeniya*, and the *Botanic Gardens* at Hakgala and Hematgoda. Trial cultivation was followed by private planters in their estates from 1930 onwards up to the present date in seventeen localities in rubber, tea and cocoanut plantation areas between an elevation of 50' and 5,000'. The results hitherto obtained from those experimental cultivations prove that *A.montana* is more easily acclimatized in the island than the more temperate species *A.Fordii*.

It was noticed that *A.Fordii* had failed repeatedly in all localities in the Island where

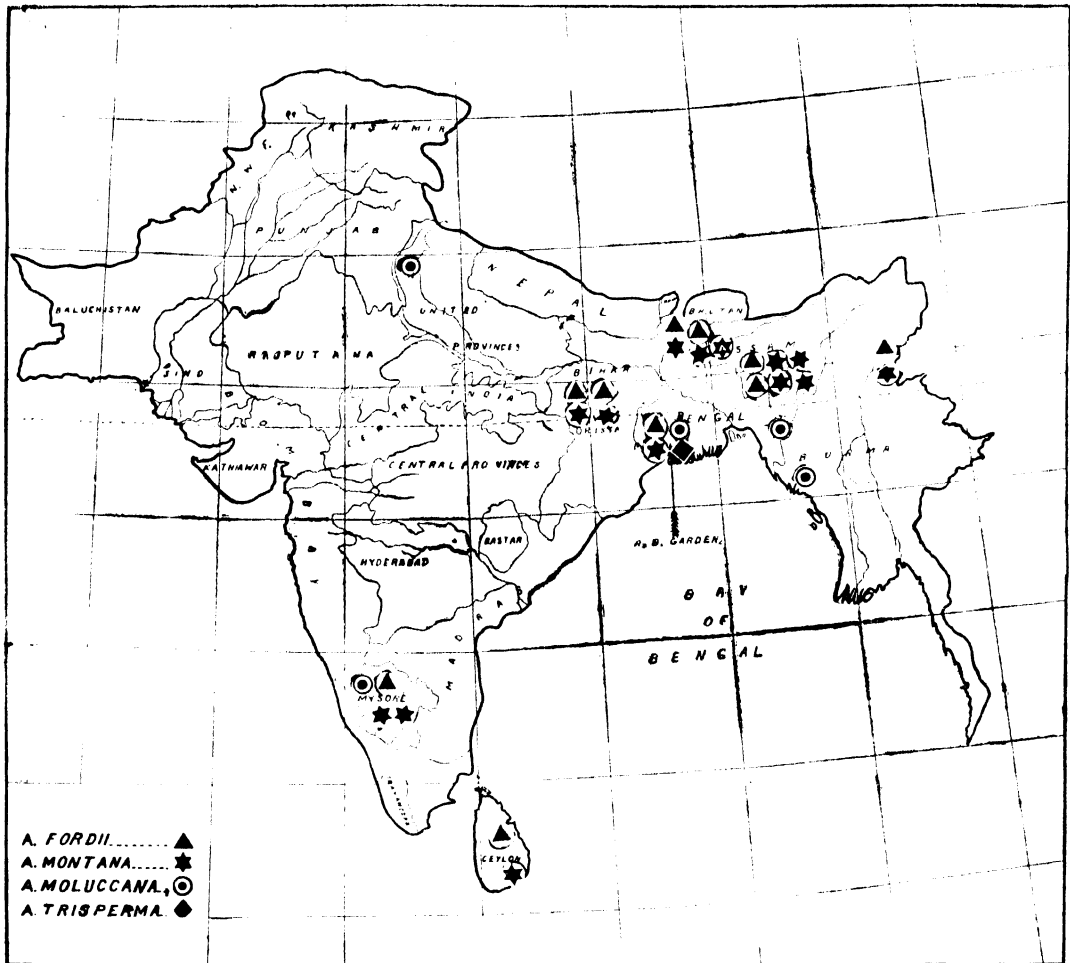
attempts were made to establish it. The progress of *A.montana*, however, was satisfactory in mid-country. The Department of Agriculture, therefore, decided in 1938 that *A.Fordii*, having been proved by repeated trials to be unsuited to Ceylon conditions, should not be persevered with any more.

The analysis of the oil from the seeds of *A.montana* grown in Ceylon indicates that the quality of the oil is quite suitable for industrial and commercial purposes—although the *Research Association of British Paint, Colour and Varnish Manufacturers*, considers that *A.montana* oil is only slightly inferior in quality for the manufacture of high class varnish. This view is, however, disputed and it is considered, as a result of recent analyses, that the oil is in some respects preferable to that of *A.Fordii* for some industrial purposes.

Cultivation in India and Burma

Attempts have been made to introduce the tung oil yielding trees—*A.Fordii* and *A.montana*—at the *Royal Botanic Garden, Calcutta*, for more than a century. *A.montana* and *A.Fordii* were actually introduced to the *Royal Botanic Garden* as early as 1828. Cultivation in India of particularly *A.Fordii* had also been a subject of correspondence between the Superintendent, the then *ex-officio* Director, Botanical Survey of India, and other Departments of the Government and the then *Imperial Institute* of London, immediately after the last war in Europe. A small consignment of fresh seeds was received in 1918 by the Superintendent, *Royal Botanic Garden, Calcutta*. These seeds were experimented upon in the *Royal Botanic Garden, Calcutta*, the cinchona plantation at Mungpoo (Darjeeling) and Southern Shan States, Burma. Very little information on the results of the growth of the plants raised from the seeds supplied, is, however, available.

The Director, *Royal Botanic Garden, Kew*, sent a large consignment of about half a ton of the seeds of *A.Fordii* to the Superintendent, *Royal Botanic Garden, Calcutta*, in March 1931. These seeds whose viability was affected to a certain extent due to long transit, were distributed, as soon as they were taken delivery of, to more than 20 firms in various parts of India together with notes on the method of cultivation. The different tea estates in Assam were particularly interested in the cultivation of this



Map 2—Areas where Tung oil yielding trees are cultivated in India.

economic plant. In fact, some of the large tea estates in Assam were very enthusiastic in starting experimental plantations.

Considerable literature and valuable records regarding various methods of cultivation of tung oil trees in Ceylon and in the other parts of the world are at present available. General methods of manuring, nursery management, transplanting, propagation, horticultural manipulation and harvesting, have been developed. These methods, however, depend on the edaphic and climatic conditions prevalent in the different countries. As regards India, distinct methods will have to be evolved after prolonged experimental cultivation in various parts of India which are favourable for growing the two tung oil trees. Soil condi-

tions and climates and other biological factors vary in different parts of India. It is, therefore, by no means an easy task to discover for India a standardized method of successful cultivation of tung oil trees in suitable places on a commercial scale.

In their natural habitat in China, tung oil trees prefer warm temperate parts rising up to an elevation of 3,000' and can grow well on conglomerate, hard limestone and sandstone. *A. Fordii* and *A. montana* are essentially hillside plants in their native habitats thriving on rocky areas and even on poor soil, which, however, has not been the experience of some growers in India and Burma. They are capable of withstanding, a minimum rainfall of 30" per annum and the trees do not like too much water although

they grow equally well in areas with a rainfall of 70"-110" per annum.

Records of cultivation as a result of experiments on the seeds distributed from the *Botanic Garden* in 1931-32 show that only a few areas in India might prove to be suitable for successful cultivation on a commercial scale. Judging from the rather meagre data at present available, it appears that the best place for their cultivation would be in the lower ranges of the comparatively well drained regions of N.E. India and Northern Burma (the Southern Shan States) from an elevation of 2,000' to 4,000' which is rich in humus, free from frost and generally covered with forest as protection against wind and hail and hailstorm. There is in Northern Burma at present 50,000 acres under cultivation of *A.Fordii* and *A.montana*.

Of the two species—*A.Fordii* and *A.montana*—*A.montana* seems to be more favourable for successful cultivation in India at a lower level than *A.Fordii* which is rather delicate and prefers a colder climate and higher elevation, although *A.Fordii* has been grown in the plains of Bengal (Cooch Behar and Botanic Garden), and flowered and fruited sporadically. Experiments in Mysore reveal that *A.montana* can be successfully cultivated in several parts of the State between elevations of 2,500' and 3,000' with a rainfall of over 60" per annum. *A.Fordii* has been tried experimentally in several parts of the State and found to be unsuitable. In the tea plantations of Ranchi in Bihar, there were about 7,000 trees. The *Indian Lac Research Institute, Ranchi*, devoted about an acre of land for growing tung trees. Their experiments conducted since 1928 have now been given up with the conclusion that germination from local seeds is as good as from imported seeds, that the oil-content of native fruits is comparable in quantity with that produced in other countries and that the quality of the oil obtained is of the approved standard.

In Assam alluvial soil of ordinary tea plantations with occasional stony outcrops seems to be most favourable for the cultivation of *Aleurites*. Rainfall varying from 70"-110" and a maximum temperature of 96° F. and a minimum temperature of 43° F. with high humidity are not unfavourable for the successful growth of *A.Fordii* and *A.montana*.

Tung oil trees do not like too much water and are likely to die in waterlogged

areas. The usual plantation procedure as regards manure, nursery arrangements, transplanting, timely weeding, etc., have to be carried out during the earlier stages of the growth, as practised elsewhere, particularly in Florida.

Different methods of cultivation have been adopted in different areas and in some cases manuring was necessary.

The results of cultivation in different parts of the country and in Northern Burma during the last decade indicate that *A.montana* is more vigorous and disease-resistant than *A.Fordii*. It can be grown easily in well-drained soil in valleys and along hillsides from an elevation of 1,500' to 4,000' with considerable success. The ideal elevation is between 2,500' and 3,500' without frost. The yield of fruits in *A.montana* is also much higher than that of *A.Fordii*.

A.Fordii and *A.montana* are two very distinct plants. I cannot endorse the view that either *A.Fordii* or *A.montana* can grow on poor rocky hillsides. They are both found to be exacting in soil requirements. They cannot succeed on poor soils and without much attention. The natural habitats of *A.Fordii* and *A.montana* are not the same. *A.Fordii* grows at a higher altitude and needs better drainage than *A.montana*. I would put the minimum rainfall for plantation-grown tung at 50"; a rainfall of 30" is too low. The maximum does not matter if the drainage is good. Maximum elevation for *A.montana* is 2,500' and for *A.Fordii* 3,500' but without frost. If the soil is more alkaline than pH 5.6, the growth is poor.

A.moluccana (*Akrot*—native of Sylhet) is useless for industrial purposes; it yields a semi-drying oil which does not gelatinize. There is nothing approaching a pure line of *Aleurites* species and in any normal population, a great variety of types can be found. Some are high yielders and some low. Given uniform growth conditions there are still large fluctuations in yield due to differences in the trees themselves. The fact that the male flowers open before the female, does not lead to sterility in a plantation. Only in isolated trees, sterility may be attributed to this factor but even in such cases, as the flowering period of any single tree covers about three weeks for *A.Fordii* and six weeks for *A.montana*, there is sufficient chance for cross pollination and effective fertilization.

The yield of fruits depends on several factors. Many trees which are quite healthy, yield but few fruits. This shows that it is not due to the trees themselves but to some external and internal inhibiting factors which prevent higher yield. The main factors which affect the yield of fruits are the physiological condition, sex behaviour and local meteorological conditions such as norwesters, hailstorms, heavy showers of rain and strong winds blowing steadily for considerable hours immediately after the flowering period. The flowers exposed to these adverse conditions drop off before fertilization resulting in poor yields. To counteract such unfavourable conditions, sheltered spots of the hillside or the plain not directly exposed to the inclemencies of the weather should be selected. A fringe of forest left on the windward side as a screen will not only prove to be a safeguard against the damage by stormy winds, but it also prevents erosion and helps in increasing fertility.

The important biological factor involved in the lowering of yield of fruits and seeds is the production of predominantly male flowers in a plantation. This depends on the nature of the genes in the chromosomes of the embryos in the seeds selected for growing in a plantation. If the seeds come from monoecious trees where male flowers are dominant, then the progenies are likely to yield a larger number of male flowering trees and a smaller number of female flowering trees. If, however, the seeds are selected from the dioecious female tree or monoecious but dominantly female flowering trees, there is every likelihood of getting the maximum number of female trees much to the advantage of the plantation. In this manner by gradual elimination of seeds having recessive and, dominant male genes, segregation of male trees is possible in a plantation.

In Assam, *A. Fordii* suffers much more from waterlogging and from die-back than *A. montana*. Flowers of *A. Fordii* are borne on clusters made up of the one terminal female flower surrounded by a varying number of male flowers. Males open before the female. For increasing the yields in this species, it will be necessary to take a selected stock of trees of cluster bearing fruit, as is being practised in America.

The best way to increase the yield is by means of vegetative propagation of high yielding female trees. Grafts, and buddings from the female trees are likely to turn out to be female and produce a large number of female flowers.

Vegetative Propagation

The flowers in *A. Fordii* and *A. montana* show various combinations of sex. Generally, male flowers are predominant in both the species of tung trees. The male flowers are usually *protandrous*, that is, they open and mature earlier than the female flowers. The prospect of much higher yield than those grown from unselected seeds, by budding, or grafting from two selected high yielding mother trees is to a large extent ensured. Experiments on different methods of grafting, layering and budding have been more or less successful in some of the plantations in different parts of India and abroad. A simple method of budding has been suggested by Mr. Webster.*

Biology of the Flowers

The flowers are often self-sterile. Therefore, effective fertilization depends on cross pollination. Production of both the male and female flowers in *Aleurites* is highly irregular as shown below.

* Webster, C. C., *Nyasaland Agricultural Quarterly Journal*, 1941, 1, No. 1.

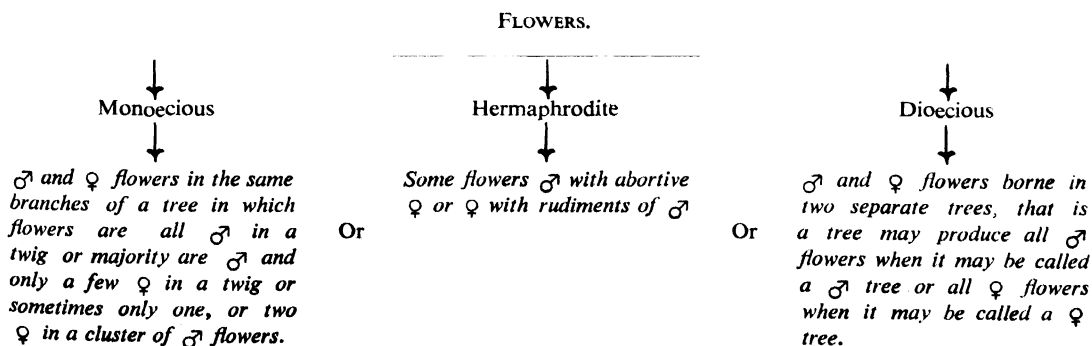




Fig. 1.—*Aleurites Fordii* Hemsl.

Pollination is, therefore, extremely variable. Flowers are generally *protrandous* or sometimes *protogynous* and *anemophilous* or *cistomophilous*, so that cross pollination is effected between the mature early or late flowering male tree or a branch, and mature early or late flowering female tree or a branch or *vice versa* as the case may be, because the flowering period varies between three and six weeks, as mentioned before. A number of male flowering trees is, however, indispensable for the purpose of effective pollination. The sex behaviour of tung oil yielding tree is comparable to that of the papaya (*Carica papaya*) tree to a certain extent.

Plantation of tung oil yielding trees is, therefore, a commercial proposition if the area planted has maximum number of female trees of high bearing capacity. It is not until the flowers come to maturity that the sex question can be determined and this can be complicated by the fact that in the early years, the sex may change, usually from female to male. Such being the case, it is important to take recourse to vegetative propagation by means of early budding or grafting from high yielding female trees as rightly suggested in the report of the *Tea Association* on tung trees.

A. Trisperma and *A. moluccana*, the two Indo-Malayan species recorded from Sylhet and Chittagong about 105 years ago by Nathaniel Wallich, a former Superintendent, *Royal Botanic Garden, Calcutta* (1817), and reported even earlier by Roxburgh, the first Superintendent of the *Royal Botanic Garden, Calcutta* (1793), have been found to behave, as regards sex behaviour, more or less in the same way as *A. Fordii* and *A. montana* which are still under cultivation in the *Royal Botanic Garden, Calcutta*.

The vagaries of sex behaviour, and other physiological defects such as die-back, etc., might be overcome by judicious hybridization with allied species as it is known that different species of *Aleurites* cross readily. It is not difficult to produce a suitable hybrid by using one of the wild species of *Aleurites* as stock. Other horticultural manipulations such as budding, grafting, layering and cutting down of the branches bearing male flowers and thereby inducing the growth of female flowers or stimulating the male flowering trees or branches to produce female flowers by administering chemicals

or plant hormones are effective in producing high yielding healthy plants. The chromosome numbers, and possible variation in their structures in ♂ and ♀ trees may be ascertained at a very early stage of growth by the "smear method" and thus it might be possible to eliminate the requisite number of male trees at the initial stage. Such experiments will have to be carried out both in the field and in the laboratory in order to achieve the desirable results of far-reaching practical value. Detailed cytogenetical investigation is also of great importance in deciding the sex problems of these highly variable species of tung trees.

In the reports of the *Indian Tea Association* on tung trees, it is stated that experiments in Assam have shown that *Aleurites montana* grows much better than *A. Fordii* and there are cases where the yield of this tree can be regarded as of commercial value in Assam; assuming a price of Rs. 80 per maund, a yield of 888 lbs. of husked seed per acre represents a value of Rs. 88. This is from random planting with no attempt at selecting female trees. In the case of *A. montana*, the trees are either almost entirely male or female. If an area is planted mostly with female trees, with a few male trees for effective pollination, the yield per acre would be greatly increased. Individual trees can give as much as 89.9 lbs. of husked seed per tree and 50 acres would then give 4,495 lbs. valued at Rs. 449.

From the data gathered hitherto from many sources, I am now in a position to state that there is sufficient prospect in India of successful cultivation, on a commercial scale, of tung oil yielding trees, *A. montana* and *A. Fordii*. They can be grown easily on a large scale in suitable areas on good, well drained soil, specially in the different tea estates in N.E. India. Cultivation of *A. montana* is preferable to *A. Fordii* in some places, particularly in Assam, N.E. Bengal, some parts of Bihar (Ranchi District) and S. India. Viable, disease-resistant seeds yielding a large quantity and better quality of oil may be obtained from an experimental plot attached to the plantation. Such an area in each plantation should be set apart for experimental cultivation where only high yielding female trees will be kept growing segregated from others in order to avoid contamination of the genes by natural crossing.

Method Recommended

The method of cultivation to be followed in various parts of India should be more or less the same as practised in Florida.

Not much attention has so far been paid to the selection of suitable soil for the cultivation of tung trees. It is presumed that ordinary garden soil, which is sufficiently fertile, well-drained, well-irrigated and slightly acid, will serve the purpose. Actual experiment in Burma, however, has shown that well-drained sandy loam or sandy soil with 3'-8' subsoil and a cover of sufficient humus or leaf-mould is best suited for the cultivation. The most important point is to see that the soil is fairly fertile and at the same time moist, but it must be well drained.

Nursery.—The site for the nursery should be situated in a well-irrigated and well-drained locality. The soil should be kept properly moist but well drained all the time during the dry and spring season when the seeds should be sown in the nursery beds. It is safer to grow plants from seeds first in a well-protected nursery and then transplant them in the open after six months, selecting only healthy seedlings from the beds. Broadcasting is done in some places, but the results obtained are not very satisfactory. In some cases sowing has been practised at the beginning of the cold weather and transplanting some six to eight months later. If the locality is situated in a dry zone, it becomes a problem to keep the soil well irrigated and moist during the long dry, hot period, but at the same time, sowing of seeds in winter after the fruits drop in autumn, gives better germination. Normally about 60 days are required for the germination of the seeds, depending on the viability of the seeds, the nature of the soil and meteorological factors. Selection of good high yielding viable seeds from female plants before sowing is, therefore, as has already been stressed, very important with a view to securing uniform germination of the seeds, and for budding purposes later on, in order to eliminate the male plants. To minimize the period of germination and other difficulties often experienced in the nursery, Shear and Crane* recommend treatment of seeds by penetrants, such as *morpholine*.

Single seeds (not the whole fruit) should be planted 3" or 4" deep and from 8" to 12" apart in the nursery row. Experiments may also be carried on to expedite germination by using plant hormones. In heavy soils, the seed should not be planted at a greater depth than two inches. The nursery should be free from grass and weeds and good dust mulch should always be present. Tung oil plants are shallow rooting; therefore, deep cultivation should be avoided after a month. Nursery rows should not be less than 3' apart to permit of shallow cultivation between them throughout the growing season in the nursery. Although a period of two months is required for the germination, the seeds sometimes sprout even after three months.

Transplanting.—Before the trees are transplanted, the soil in the plantation area may be slightly ploughed and hoed. Deep ploughing after transplantation would be injurious to the plant which has developed mostly surface roots. The area to be cultivated should be properly cleaned, weeded and treated with leaf-mould if the soil is not sufficiently rich in humus. In some places in Assam, tractors have been used for ploughing and cleaning the field with better results, but deep ploughing along the hillsides is not recommended as such a course will accelerate soil erosion.

Transplantation should be done after about six months. Care should be taken to select healthy plants. The planting method to be followed is more or less the same as practised in planting fruit trees. It is advisable to undertake transplanting operations in June and July soon after the rains set in. Deep planting is injurious to the seedlings. Distance for planting seedlings should be the same as in the nursery. After the seedlings have been transplanted and established, they should be cut down to a stub of 12" to 14" above the ground. No further pruning of young trees is required except the pruning of the tips of the plants to stimulate the growth of lateral branches close to the ground. Thinning operation should come next and sick and delicate plants should be eliminated and the spacing of healthy trees should be the same as in orchard trees. For proper growth, 20' each way will be sufficient space. Distance of 25' × 30' or even 30' × 30' may be adopted with reference to the nature of the growth of individual trees in a plantation.

* Shear, C. B., Crane, H. L., *Bot. Gaz.*, 1943, 105, 251, 256.

It has been suggested that trees should be planted in parallel rows 12½' between trees in the row, and 30' between the rows. After the seventh year, alternate trees should be removed which will leave 25' between two trees in the same row and each tree will be 32½' diagonally removed from its nearest neighbour in adjacent rows. It is calculated that the extra yield of fruit before the alternate trees are removed is sufficient to justify this practice. This arrangement finally bears 60 trees per acre.

Manure.—"The fertilizer needs of the tree have not been fully determined except to prove that young trees respond quickly to light applications of nitrate of soda or of Peruvian guano up to 1 lb. per tree. Old stable manure is also good." Use of leaf-mould and cultivation between the trees by leguminous cover crops is recommended to keep the soil moist, aerated and rich in nitrogen.

Collection of fruits.—"In China it is usual to knock the fruits off the trees before they are perfectly ripe. The husks are then removed by parching the fruit in iron pans over a fire or by collecting the fruit in heaps and allowing fermentation to take place to loosen the husks. Alternatively, the fruits may be harvested at leisure after having fallen to the ground as they do not deteriorate through lying on the ground for a few weeks, and they are not eaten by cattle because of the disagreeable taste. The seed proper, after being removed from the husk, can be stored in any dry place for an indefinite period. However, if the seed is to be used for planting it should only be removed from the husk immediately before planting, and should not be carried over from one season to another."

Husking and Extraction of Oil.—The method of husking and extraction of oil may be done by up-to-date machinery as in America. The trees may bear flowers after the third year, but it is expected that the trees will flower and fruit from the fifth year. The maximum crop is expected from the tenth year and from then on they, specially *A. montana*, continue to bear fruits for more than 20 years. In some places it is observed that the tree bears bumper crops every alternative year.

The cluster types of tung trees are preferable to single and a few fruiting types. There has been some controversy over the cultivation of some crops in between the

rows of tung oil trees in a plantation. It is likely to prove advantageous if some shade trees belonging to the leguminous family are grown in between. Cultivation in the middles by small leguminous shrubs, preferably annual, biennial or perennial crops, such as *peas*, *Crotalaria*, *Tephrosia*, *Indigofera* and other leguminous crops, can be undertaken with a view to increasing the nitrogen content of the soil and controlling the balance of acidity. Such a step helps also to till and fork the soil and thereby to maintain aeration and to check water-logging.

The cost of cultivation as far as the records reveal varies from 20 to 40 rupees per month per acre. The cost will, however, decrease from year to year as the plantation is brought under control.

There should be as mentioned above, an experimental plot in each plantation for investigating the possibilities of producing better types of *A. Fordii* or *A. montana* or both by propagating potential female trees of high yielding cluster forms, and also finding out means of maintaining the quality of the trees producing disease-resistant seeds yielding better quality and quantity of oil. Hybridization between *A. Fordii* and resistant *A. montana* and also *A. Cordata* or even *A. Trisperma* and *A. moluccana* should be tried under a variety of Indian conditions. Crossing experiments based on up-to-date genetical and cytogenetical knowledge should also be undertaken in order to solve the sex problem in the tung oil yielding trees. Problem of germination, healthy growth, shading and manuring and various other questions should also be tackled in the experimental plantation.

Tung oil, or as it is commonly known the China wood oil, is of considerable commercial value. The United States of America imported tung oil valued at Rs. 54,514,342 about four years ago. The quantities of oil exported from China to the United States of America and to the United Kingdom, ten years ago, were respectively 50,000 tons and 4,000 tons. Tung oil is invaluable in the manufacture of paints and varnishes and in the caulking of aeroplanes and sea-going vessels. It has been rightly emphasized that the tung oil industry should be developed in India as a village industry as it was done in China.

Literature consulted.

- 1 Anon, *Ind. For.*, 1940, 66.
- 2 *Amer. For.*, 1932, 38, No. 4.

- 3 Biswas, K., *Bengal Weekly*, Nov. 1939; *Proc. Roy. Asiatic Soc.*, 1940; *Abstracts, Proc. Ind. Sci. Cong.*, 1943.
- 4 *Bull. Imp. Inst., London*, 1932, 30, 24, 271; 1933, 31, 327; 1940, 38, 5.
- 5 Bunting, B., *Malayan Agri. J.*, 1931, 19, No. 4.
- 6 Cooke, T., *Flora of Bombay*, 1908, 2, 626.
- 7 *Empire Marketing Board Bull.*, No. 31.
- 8 Gardener, H. A., *Questions and Answers on Tung Oil Production in America*, 3rd Edition, 1930 (American Tung Oil Corporation).
- 9 Hon. H. C., *Lingnan Sc. J.*, 1939, 18, No. 4.
- 10 Hooker, J. D., *Flora of British India*, 1890, 5, 384.
- 11 *Indian Tea Association (Scientific Department)* 1936, and *Research Circular No. 47*, 1939.
- 12 Jordon, L. A., *J. Oil and Colour Chem. Assoc.*, 1929, 12, No. 107; 1930, 75, No. 1, *J. Roy. Soc. Arts*, 1935, 83, No. 4302.
- 13 Kanjilal, U. N., De, R. N. and Das, A.—*Flora of Assam*, 1940, 4, 191.
- 14 Laurie, M. V. and Sen Gupta J. N., *Ind. Forest Rec.*; (New Series) *Silviculture*, 1941, 4, No. 3.
- 15 Legros, J., *Monthly Bull. Agri. Sc. and Pract.*, June, 1937.
- 16 Long, A., *Ind. For.*, 1933, 59, No. 9.
- 17 *Monthly Bull. Agri. Sci. and Pract.*, 1937, 28.
- 18 Mooney, H. F., *Eastern States Forest Bull.*, 1938, No. 3.
- 19 Muthana, M. A., *Qtly. J. Mysore Forest Deptt.* 1937, 5, No. 4.
- 20 Norris Dorothy and Bates, H. T., *Ind. For.*, June 1930.
- 21 *New York Times*, 1938, 111, No. 12.
- 22 Osmaston, F. C., *Nursery and plantation notes for Bihar and Orissa*, 1929.
- 23 Parker, R. N., Rau, M. G., Robertson, W. A. and Simonsen, J. L., *Ind. For. Rec.*, 1924, 10, Pt. 2.
- 24 *Production of Tung Oil in the Empire*—Memorandum prepared by the Imperial Institute, June, 1930.
- 25 *Rep. For. Adm. Mysore State*, 1936, 1937 and 1938.
- 26 Roxburgh, W., *Flora Indica*, Carey's Edition. 1874.
- 27 Sands, W. N., *The Malayan Agri. J.*, 1924, 12, No. 1.
- 28 Sen Gupta, J. N., *Ind. For. Rec.*, 1937, 2, No. 5.
- 29 Shear, C. B., Crane, H. L., *Bot. Gaz.*, 1943, 105, 251, 253.
- 30 Smits, M. B., *Intern. Rev. of Agri.*, 1931, 32, No. 8; *Trop. Agri., Ceylon*, 1931, 77 340.
- 31 Troup, R. S., *Exotic Forest Trees in the British Empire*, 1932.
- 32 *Trop. Agri.*, 1931, 77, No. 6.
- 33 *Trop. Agri.*, 1941, 97.
- 34 Webster, C. C., *Nyasaland Agri. Quart. J.*, 1941, 1, No. 1; *Trop. Agric.* 1941, 97, 103.

MANUFACTURE OF YEAST IN INDIA

SOME SCIENTIFIC PROBLEMS

By P. N. VOHRA AND BASHIR AHMAD

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IN an earlier communication¹ the nature and importance of yeast was discussed in some detail.

The existing sources of yeast in the country are the breweries and the distilleries. Both produce yeast as a by-product. It is estimated that about 5 per cent. of the carbohydrates consumed in those factories is utilized by the yeast.

India produced in the neighbourhood¹ of 9,241,356 L.P. gallons per annum of various spirits before the war². During the war period, the power alcohol industry received considerable encouragement. It is estimated that there are 83 distilleries in the country producing 14.94 million gallons of alcohol³. On the basis of 5 per cent. sugar consumed for the production of yeast, the total amount of dry yeast which can be obtained from the distilleries would be approximately 3,000 tons.

There are only a few breweries in India. Table I shows the number of breweries and their production during the five year period 1935-39, for which figures are available.

TABLE I. *Total Production of Beer in India*⁴.

Year	No. of breweries	Total production Gallons
1935	7	1,254,588
1936	6	1,159,470
1937	6	1,239,629
1938	6	1,176,766
1939	6	1,234,478

It is calculated that only 10.5 tons of dry yeast is recoverable from these plants. The total output of yeast from all the breweries and distilleries put together is about 3,010 tons of dry yeast, a quantity which is just sufficient to supply the requirements of about 0.05 per cent. of the Indian population. There

is great need, therefore, for the establishment of food yeast factories in this country.

By-product Yeast from Distilleries and Breweries

The yeast sludge obtained at present from the distilleries is not suitable for the recovery of food yeast. The following improvements in the process are necessary to render the yeast fit for human consumption :—

- (a) The molasses mashes should be clarified and filtered to remove all undesirable matter which yields the mud in the yeast sludge.
- (b) The mashes should be sterilized before fermentation.
- (c) The open fermentation vats should be substituted by covered fermentation tanks. This would prevent contamination of yeast during fermentation; at the same time it will facilitate the recovery of carbon dioxide.

After the fermentation is complete, the yeast settles down at the bottom. The bottom yeast can be run into another tank, washed with cold water, and separated by means of high speed Laval separators. A simpler method which has been developed by the authors consists in flocculating the yeast and filter pressing. The product obtained has a high nutritive value.

Since all the breweries use hops in the manufacture of beer, the brewery yeast is bitter in taste but is still valuable. It can be easily filter pressed. In order to remove the bitterness and make it palatable, many methods have been suggested. The following may be mentioned :—

- (a) Extraction of dry powdered yeast 2-3 times with methyl alcohol⁵.
- (b) Washing with fresh water and further treatment with 4 volumes of 2 per cent. cold sodium carbonate or 1 per cent. ammonium carbonate solution and drying⁶.
- (c) Washing and debittering by treatment in a tank with ice-cold 1-2 per cent. sodium or ammonium carbonate solution. The yeast is then passed through a separator into another tank containing enough of HCl to adjust the pH of the yeast suspension to 5.0. The yeast is separated on the centrifuge and dried.⁷

Yeast Production in India

Raw Material.—The amount of B vitamins in yeast depends largely upon the

nature of the medium in which it is grown. The yeast grown on malt medium is richer in vitamins than that grown on molasses⁸. In the experience of the authors, the yields of yeast also on grain are better than on molasses but the cost in the case of the latter is much less. A medium has to be devised which while yielding a nutritionally potent yeast (as from grain) should be as cheap as that from molasses.

India has abundant supplies of both the raw materials. Barley, the chief grain used in the manufacture of yeast, is available at present at a price of Rs. 4-8 a maund, while its pre-war price was Rs. 2 a maund. Molasses which used to cost As. 2-8 a maund is still available at As. 8 a maund, *ex* factory. The total production of molasses is 683,000 tons and of barley 2,313,000 tons a year.

Sources of Nitrogen and Phosphorus.—Yeast can easily assimilate inorganic nitrogen (e.g., am. sulphate) and synthesize proteins. When organic nitrogen is also supplied, the yields are much better. Malt mashes from barley supply adequate quantities of organic nitrogen. Some amount of ammonium sulphate is produced in the country, and plans for the production of more are on hand. The present price of ammonium sulphate is Rs. 13-8-0 per cwt.

Phosphates can be supplied in the form of calcium superphosphate, the production of which is being undertaken in the country. Further quantities of calcium superphosphate can be manufactured because sufficient raw materials exist in this country for its production. The present price of superphosphate is Rs. 250 per ton.

Yeast Strains.—Ordinary yeast (*S. cerevisiae*) requires a temperature of 25-30° C. for optimum growth. The average temperature in India varies widely throughout the year, and in the northern parts, the temperature is too high during summer for yeast culture. Refrigeration arrangements have to be installed in order to make the factory operation possible. It has been found, however, that yeast can be acclimatized to higher temperatures, and suitable strains have been developed which can grow vigorously at as high a temperature as 39° C. Certain yeast strains have been found to be especially suitable as food yeast due to their producing more proteins and little or no alcohol. *Torula utilis* is one such strain. *Torula utilis* var. *thermophilis* developed at Teddington,

withstands high temperatures. Selected strains can be acclimatized to high temperatures under Indian conditions.

Increase of Nutritive Value.—The vitamin value of yeast can be increased by supplying necessary *bios* factors in the medium. It has been found that yeast can synthesize vitamin B₁ and also absorb it from the medium. It has already been stated that yeast grown on malt is richer in vitamins than that grown on molasses.

Yeast Separation.—The proper separation of yeast from mashes is a problem by itself. Yeast cannot be ordinarily filter pressed because the filtration is slow, and unless the process is carried out at a low temperature, autolysis takes place. Special types of high speed centrifuges have been employed for yeast separation. A simpler procedure is to flocculate the yeast to facilitate filter pressing.

Location of Plant.—In choosing the site for a yeast factory, the following points have to be considered, in addition to proximity to the sources of raw materials :

- (1) Atmospheric temperatures (to minimize refrigeration costs),
- (2) Disposal of effluents,
- (3) Availability of water-supply, and
- (4) Cheap power.

It has been calculated by the *Colonial*

Food Yeast Co., England, that about 10,000—12,000 gallons of effluent issue out per hour from a yeast factory of 3,000 tons capacity. Near about 21,000 gallons of water at 75° F. are required for cooling coils required to maintain optimum temperature conditions during fermentation.

Manufacture of Yeast

A semi-commercial scale plant has been set up, from a grant provided by the *Council of Scientific and Industrial Research*, for investigating problems of yeast production. The results of these experiments will be reported in a later communication.

The plant is shown diagrammatically in Fig. 1. It consists of a mixing tank for molasses, a tank for mashing malt, a sterilizer, two wort storage tanks, a seed yeast fermenter, three fermenters, a centrifuge pump, an air compressor, a centrifugal machine and a yeast drier.

The plant has an output of approximately 10 lbs. dry yeast per day under aseptic conditions.

Wort.—The molasses as purchased from the market, requires preliminary clarification. The molasses from the sulphitation process is to be preferred to that from the carbonation process. For clarification, the

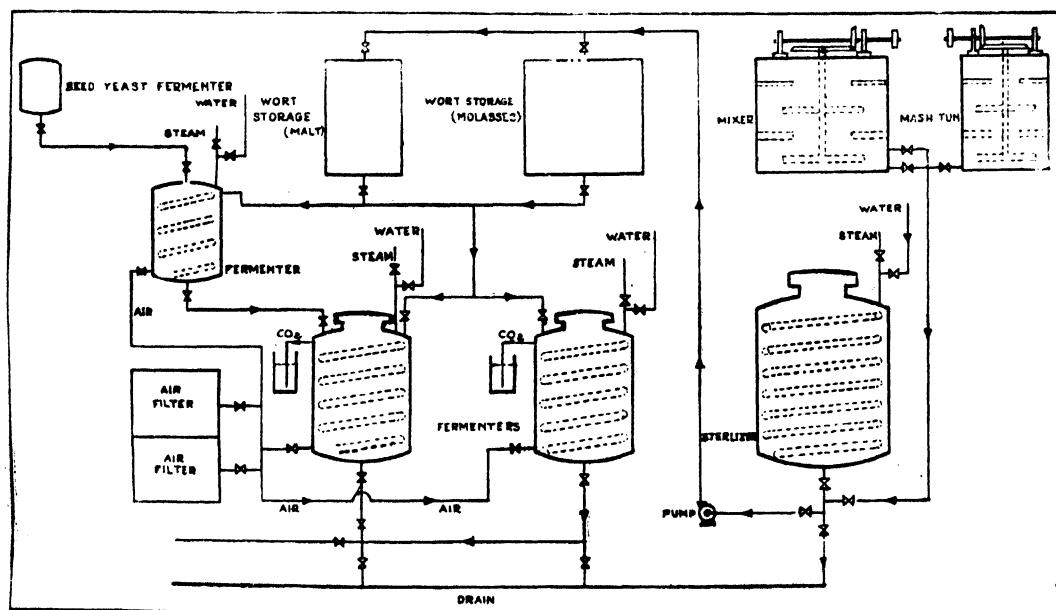


Fig. 1.—Flow-sheet of Pilot Plant for manufacture of food yeast.

molasses is diluted in a mixing tank, acidified and boiled. A small quantity of calcium phosphate is then added and the boiling continued for half an hour. After cooling and neutralizing with milk of lime or ammonia, the mixture is allowed to stand for about 12 hours. A sediment separates out and the supernatant clear solution can be decanted off. It is sterilized by boiling for about half an hour under pressure and pumped while still hot into the molasses wort storage tank.

The ground malt is mashed in a mash tun to give a wort of 1,040-1,045 gravity, and after sterilization, stored in the malt wort tank. A mixture of these two worts is used for growing the yeast.

Seed Yeast and Incremental Fermentation.—The pure culture of yeast is transferred from the agar slant to 10 c.c. of sterile glucose-salts media and incubated at 30° C. At the end of 48 hours, the entire medium (Generation I) is transferred to 100 c.c. of sterile malt wort (gravity 1,040) and incubated for 48 hours, the normal time for good growth. The medium is subsequently transferred to 500 c.c. of sterile malt wort and after 24 hours again to the seed yeast fermenter containing 4,000 c.c. of sterile malt wort. The medium is aerated after 12 hours. The contents of the seed yeast fermenter are transferred after 24 hours to the first fermenter containing 16 litres of media and growth allowed to proceed for 12 hours. 8 litres of media are added at regular intervals during the remaining 12 hours. Air is supplied throughout. The contents of this fermenter are transferred to the main fermenter containing 128 litres of media and vigorously aerated. After 12 hours, half of the brew is transferred to the auxiliary fermenter

and additional wort supplied to both the fermenters at regular intervals to maintain the sugar concentration.

In all, a total volume of 450 litres of brew containing 7 per cent. sugar is handled within 24 hours. On the basis of 20 per cent. yield, a net amount of 10 lbs. of dry yeast per day is obtained.

Separation, Washing and Drying.—The brew is transferred to a tank and cooled. After centrifuging, the yeast cream is suspended in water, washed free from the medium, flocculated, filter pressed and dried.

The dried yeast so obtained is light cream in colour, and is free from any bitter or unpleasant taste. The vitamin B₁ content is 30 µg per gm. which is comparable to good quality food yeast manufactured in other countries.

The authors desire to thank the *Council of Scientific and Industrial Research, Delhi*, for financing these investigations. Their thanks are due also to Messrs. Gurdas Singh and Imam-ud Din of the Punjab University Institute of Chemistry, and Agricultural Machinery Manufacturing Co., Lahore, respectively, for valuable help in the fabrication of the plant.

References

- 1 Vohra, P. N., and Bashir Ahmad, *J. Sci. and Ind. Research*, 1945, 4, 191.
- 2 *Statistical Absts. of Brit. India*, 1941, p. 582.
- 3 Sen, H. D., *Annual Rev. of Biochem. and Allied Research*, 1944, 14, 87.
- 4 *Statistical Absts. of Brit. India*, 1941, p. 572.
- 5 Kröulik, A., *Ger. Pat.*, 630, 136 (1936).
- 6 Bari, Z., *Ber ungar. pharm. Ges.*, 1940, 16, 95.
- 7 Siebel, R. V., Weber, P. J. F., and Singruen, E., *Modern Brewery Age*, 1942, 27, 49, 77.
- 8 Pavcek, P. L., Peterson, W. H., and Elvehjem, C. A., *Ind. Eng. Chem.*, 1937, 29, 536.

TECHNICAL TRAINING SCHEME

A Press Note, dated 10th November 1945, issued by the Labour Department states:—

“In order to facilitate resettlement in civil life of demobilized technicians and secure an adequate supply of skilled personnel for post-war development plans, both Government and private, the Labour Department in the Government of India have decided to utilize the existing centres under the Technical Training Scheme to provide 30,000 seats a year for training demobilized servicemen. The scheme which has been sanctioned for three years in the first instance,

embraces a large number of engineering and building trades, and the average period of the training will be 12 months. Some adjustments will also be made in the capacity of the training centres to include certain new trades which are not catered for in the existing schemes.

“Trainees will be given free board, lodging and workshop clothing, a monthly allowance of Rs. 15, free travel facilities from the demobilization centre or their homes to the training centre and facilities for recreation, games, physical training and medical treatment.”

NITROUS OXIDE*

NITROUS oxide (N_2O) is widely used on the continent of Europe and elsewhere as an anæsthetic but its use in India has been retarded until recent years owing to the necessity of importing the gas, and unfamiliarity on the part of most medical practitioners with its properties. The gas is now produced in India† but the raw materials are at present still imported.

Nitrous oxide is manufactured by the thermal decomposition of ammonium nitrate, according to the following equation:



The gas so produced contains impurities which have to be removed before using it for medical purposes.

The plant for the production of ammonium nitrate consists essentially of decomposing vats which are heated to a temperature of about 400° F. By means of suitable catalysts, the nitrate decomposes quietly and easily, and the resultant gas is then passed through a separator for the removal of excess water. The nitrous oxide then passes in turn through scrubbing towers containing water for the removal of ammonia and other easily soluble constituents, and thence through alkaline scrubbing towers for the removal of acidic impurities, and finally, through acid scrubbing towers for the removal of gaseous basic impurities. The gas, now free from most of its impurities, with the exception of small quantities of oxygen, nitrogen and inert gaseous impurities, is then compressed to a pressure of about 30 atmospheres. The compressed gas is subjected to a rigorous process of drying in specially constructed drying chambers and is next liquefied in a counter current heat exchanger. In this way all non-condensable impurities such as nitrogen and oxygen are blown to waste and pure nitrous oxide is obtained. The pure liquid is evaporated, compressed once again, further dried and finally charged into trade cylinders. The cylinders are solid drawn steel vessels usually made to B.S.S.401. They are very similar to oxygen cylinders and normally operate under a working pressure of 1,000 lbs. sq. in. They are painted black according to *British Standard Specifications* and are

clearly marked with the usual symbols.

Nitrous oxide under a pressure of 1,000 lbs. sq. in. and at normal temperatures is a liquid. In tropical countries a smaller quantity of gas is put into cylinders than is the case in temperate climates. The reason for this is that expansion of the liquid as a result of increase in temperature could, in certain circumstances, give rise to dangerously high hydraulic pressures. The most common sizes of cylinders in use are 100 gallons and 200 gallons. For bulk supplies, cylinders up to 3,600 gallons are used. Nitrous oxide is usually measured in gallons because this is a unit favoured by the medical profession, the largest consumers of nitrous oxide. One gallon equals approximately 6.3 cu. ft. 100 gallons of nitrous oxide weigh 30 ounces. Nitrous oxide cylinders are tested every two years to a pressure of 3,360 lbs. sq. in.

Nitrous oxide is soluble in water, 1 volume of water at atmospheric pressure dissolving 1.3 volumes of nitrous oxide at 0° C. At 20° C. the solubility drops to 0.63 volumes. Nitrous oxide liquefies under a pressure of about 400 lbs./sq. in. at 0° C. and boils at -89.5° C. It freezes to a white solid if allowed to evaporate quickly. The gas supports combustion vigorously but does not burn itself.

Nitrous oxide is extensively used with oxygen for analgesic and anæsthetic purposes, and has surpassed ether and chloroform in surgery and midwifery. It is extremely safe and can be handled and stored with ease and safety. It has a pleasant smell and its administration, even over a long period, causes no after-effects. Nitrous oxide is not an irritant to the respiratory system as is ether, nor is it toxic to the heart like chloroform. By varying the proportion of gas mixture, it is possible to produce any, or all, stages of narcosis, from analgesia to deep anæsthesia. This makes nitrous oxide specially suitable for use in minor surgery and dentistry, where a deep or long period of anæsthesia is seldom required.

The chief advantage is that no elaborate preparations are required to administer nitrous oxide. In most cases control over the patient's condition is better than with any other agent, and it is possible for the surgeon to plan and carry out difficult

(Continued on page 251)

* Contributed by the *Indian Oxygen and Acetylene Co., Ltd., Calcutta.*

† The plant of the *Indian Oxygen and Acetylene Co., Ltd.*, is capable of producing 1,500,000 gallons of N_2O per month.

MANUFACTURE OF DEXTRIN FOR ADHESIVES

ON account of the conditions of war which existed, a well-known firm in Calcutta, manufacturing cardboard and paper packets by high speed automatic machinery, experienced much difficulty owing to the lack of supplies of suitable adhesives. Before the war, the firm was using an adhesive paste prepared from tapioca dextrin which they imported from the United States of America, and when this source of supply was cut off, they approached the *Council of Scientific and Industrial Research* with a request to work out a simple process which would enable them to manufacture their own dextrin from indigenous starches. The requirements which the adhesive were to satisfy included:—

- (a) That it should yield concentrated pastes with a minimum amount of water; in fact, the Calcutta firm specified that the dextrin: water ratio should be 20 : 8;
- (b) that the paste should be quick drying and the drying time should not exceed a few seconds; and
- (c) that it should be entirely free from gelling, threading, spinning or webbing during the application by rollers.

Work was carried out in these laboratories on two samples of maize starch and tapioca root flour. The processes employed for the conversion of starch into dextrin are well known. The properties of the dextrin as an adhesive material, however, vary considerably with the actual process of dextrinization, as also with the nature of the starch used as the starting material. The optimum conditions of concentration of catalyst, temperature of dextrinization, etc., for obtaining maximum yields of the best product, therefore, have to be determined for each grade of starch. Of the common methods employed, namely, dry torrifaction, acid conversion by the wet process and diastatic hydrolysis, it was found that in the case of both the maize starch and tapioca root flour, the first method yielded a material satisfying the requirements of the firm. The roasting may be conducted either under reduced pressure

or under high pressures obtainable in an autoclave.

In view of the circumstance that the requirement of the firm was only 1 cwt. a day, it was considered desirable to develop a procedure involving simple manufacturing equipment. The method which was ultimately found satisfactory consisted of adding to the starch a solution of hydrochloric acid which acted as a catalyst, then maturing and roasting at a specified temperature until the desired stage of dextrinization was reached. In the laboratory experiments, a heavy cast iron rotary roaster mounted on a horizontal axis was employed. One c.c. of strong hydrochloric acid, diluted to 4 c.c., was added to 200 gms. of maize starch. It was important that the catalyst permeated every particle of starch. The material was then allowed to mature in a well-stoppered container for at least 72 hours. Roasting was then started by slowly raising the temperature to 150° C. and maintaining the temperature nearly constant for about 5 hours, which was found sufficient for effecting the desired degree of dextrinization. The latter could be judged from the pale yellow colour of the product and also by actually withdrawing a sample and preparing the paste. It was found that 200 gms. of maize starch yielded 100 gms. of dextrin. It was necessary to keep the roaster continually in operation with a knife blade stirrer in position to maintain uniformity of temperature throughout the charge. The Calcutta firm was appraised of the process with all relevant details and they have since then started manufacturing the dextrin for their own requirements.

The undersigned records his sincere thanks to Dr. L. C. Verman, Director, Physical Laboratories, *Council of Scientific and Industrial Research*, for the kind interest he has taken in this investigation and for his helpful suggestions.

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COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

THE ninth meeting of the Governing Body of the *Council*, was held in New Delhi on 21st September 1945, under the chairmanship of the Hon'ble Sir Ardeshir Dalal, Member for Planning and Development.

The construction of a Technological Block of the *Glass and Ceramic Research Institute* in Calcutta at an estimated cost of Rs. 2,21,000, a block grant of Rs. 60,000 per annum to the Madras University for meeting the cost of a *Leather Research and Technological Institute* and a grant of Rs. 75,000 per annum to the *Tata Institute of Fundamental Research*, Bombay, for work on astrophysics, experimental physics and cosmic ray research were approved.

Among other schemes considered and accepted by the Governing Body was the survey of the uranium resources of India.

It was agreed in principle to establish a *Central Road Research Institute*. On the recommendation of the Board of Scientific and Industrial Research, the Governing Body decided that a small committee of the Board should draw up detailed plans and estimates in collaboration with the War Transport Department. It was also agreed to approach the Government of India for a special grant for the purpose.

The Governing Body decided to advertise for the staff of the *National Chemical and National Physical Laboratories*, in order to find out what talent was available in the country and what personnel was required to be trained abroad. It was also decided to offer the post of Director, *Fuel Research Station*, proposed to be established by the *Council* at Dhanbad, to Dr. J. W. Whitaker, at present Principal, Technical College, Huddersfield, England, for a period of five years.

The block grant of Rs. 60,000 per annum to the Madras University for meeting the cost of a *Leather Research and Technological Institute* was agreed to on the condition that an adequate percentage of the students to be admitted for training should be reserved for students from provinces other than Madras, and the Government of India provided the necessary funds.

Dr. Bhabha and Dr. Chandrasekhar will be associated with the new organization of the *Tata Institute of Fundamental Research*, for which the Governing Body decided to

sanction a block grant of Rs. 75,000 per annum. It was suggested that the *Institute* might approach the Government of India for additional funds.

The Governing Body also approved the establishment of a Road Research Board and the opening of training classes in Plastics Engineering and the starting of Building Research at the Thomson Civil Engineering College, Roorkee, as suggested by the Board of Scientific and Industrial Research.

Dyestuff Technology Department (Bombay): The Board recommended to the Governing Body an additional grant of Rs. 4,420, raising the present grant of Rs. 23,400 to Rs. 27,820.

The following research schemes recommended by the Board were approved.

Prof. P. K. Kichlu (*Lahore*): Manufacture of flash lamps.

Prof. V. Subrahmanyam (*Bangalore*): Pre-digestion or other processing of edible seed cakes to render them suitable for use as articles of human food.

Mr. V. V. L. Rao (*Madras*): Salvaging of electrolytic condensers.

Mr. V. V. L. Rao (*Madras*): Reconditioning of lead-acid batteries.

Mr. M. Sreenivasaya (*Bangalore*): Cyto-genetics of yeast and fungi with a view to evolve new and potent races.

Dr. B. B. Bhowmik (*Calcutta*): Manufacture of permanent magnets for electrical instruments.

Dr. B. B. Dey (*Madras*): Manufacture of photographic developers.

Prof. K. S. Krishnan (*Allahabad*): Electrical properties of alloys in the liquid state.

Prof. K. S. Krishnan (*Allahabad*): Thermionic work functions of metals and alloys.

Dr. P. K. Kichlu (*Lahore*): Manufacture of diamond tools.

Prof. H. N. Roy (*Benares*): Manufacture of better class saggers and other kiln furniture required by the pottery industry.

Mr. M. Sreenivasaya (*Bangalore*): Study of factors favouring an increase in the concentration of alcohol in distillery washes.

The Punjab Agricultural College and Research Institute (*Lyallpur*): Production of yeast in the milling and baking industry.

REVIEWS

The Indian Cotton Textile Industry, 1944 Annual. Edited by MR. M. P. GANDHI. (Gandhi & Co., Bombay), 1945. Pp. xxxvi +114. Price Rs. 5/-.

LIKE most industries the Indian cotton textile industry has passed through a critical period during the war which has now happily ended. Its manifold difficulties were caused by shortage of supplies, shortage of labour, attempts at hoarding, maldistribution of cloth, inadequate supplies of coal, etc., which necessitated the setting up of several official and non-official committees to supervise and control the industry and the promulgation of several control orders to keep the flow of goods from the fields to the factories and from the factories to the consumers among whom the Defence Forces formed a most important part. Many of these control orders are of an emergency nature and, it is expected, will be withdrawn sooner or later, thus giving the industry full scope to function and develop in normal times. They, however, form an interesting reading of the difficulties encountered and solved in a critical period, and have been dealt with in considerable detail in the *Annual*, which has recently made its appearance. This annual has been published a little later than usual, but, as if to compensate for this delay, some of the important events which took place in 1945, such as Sir Akbar Hydari's Mission to the United Kingdom, have also been discussed. The book contains a vast fund of useful information on the progress of the industry especially during the last few years, and besides giving the statistics, so far as available, on the production and consumption of raw cotton, trend of exports and imports of cotton and cotton manufactures, development of mill and handloom industry, etc., touches upon such subjects of general interest as dispersal of industry, post-war planning in other countries, 15-year plan of economic development, workers' health insurance, tax relief, utilization of sterling balance, etc. It does not even ignore the allied subjects which may have a bearing upon the future of Indian cotton textile industry such as synthetic fibres and rayon manufacture in

India. It should be in the library of all those who wish to have a handy book of reference dealing with cotton textile industry with special reference to Indian problems.

The fact that, in spite of numerous difficulties and handicaps, the Indian cotton textile industry has survived the acid test of war and did yeoman work in supplying the much needed fabrics and garments to the fighting forces, shows its essential soundness and capacity for further development. In this connection it is interesting to note that, according to the estimate made in this book, Rs. 62 crores would be required in the post-war period for the purchase of additional plant or for the replacement of worn-out machinery in order to ensure a mill production of 7,200,000,000 yards, which would give about 18 yds. per person per annum. It is suggested that a part of the sterling balance should be earmarked for the purchase of this plant and that the Government should supply the plant at a fixed rate for 10 years in the post-war period. While the need for importing textile machinery from abroad is undeniable, sufficient attention has not been paid to the possibility of manufacturing at least a part of this plant within the country. It would be very useful if, in the future editions of this annual, this aspect of the question is also studied. Similarly, while the work of the *Indian Central Cotton Committee* in improving the quality of the Indian cotton crop has been fully described and the notable progress made in this direction has been acknowledged, due emphasis has not been laid upon the necessity of devoting much greater amounts than at present on cotton and textile research. The amounts spent at present on cotton research in India are infinitesimally small compared either to the requirements of the country or to the amounts spent in other countries such as U.K. and the U.S.A. and it is very desirable that the attention of the Government, the industrialists and the public at large is directed to the utter necessity of spending much larger sums on research relating to the problems of one of India's premier industries. The experiences of countries like the U.S.A. and the U.K. have

shown conclusively that expenditure on applied research is a highly paying proposition and unless the Government and the industrialists in India are prepared to spend adequate amounts on research, there is great danger of our losing the ground in competition with the more advanced countries.

This book would certainly gain in usefulness by the inclusion of a few more graphs, which would bring out the various trends in a prominent manner.

NAZIR AHMAD.

"From the Farmer to the Consumer—A Study of Price Spreads." By M. C. MUNSHI, (Research Department of the Federation of Indian Chambers of Commerce and Industry), 1945. Pp. 43.

In this brochure the author has made a statistical study of the price spreads in respect of 12 commodities, viz., sugar, potato, rice, wheat, linseed, groundnuts, grapes, oranges, coffee, tobacco, milk and eggs. The study is based mainly on the data furnished in the marketing reports on these commodities issued by the Agricultural Marketing Adviser to the Government of India. The author has taken considerable pains in collating the available data and presenting them in 13 tables relating to specific items, indicating in each the percentage share of the consumer's price that goes to the various participants in the trade. These along with a consolidated table for all the twelve commodities indicating the producer's share, freights, etc., miscellaneous charges, wholesaler's margin and retailer's margin are appended to the brochure. The "miscellaneous charges" include cost of preparation for the market, assembling charges, handling, *octroi*, terminal tax, etc., and this omnibus heading has been devised by the author to place all the commodities on a comparable basis according to the data available.

The author comes to the conclusion that while the problem of a considerable spread between the producer's and consumer's prices is universal, in the case of agricultural products in India the margins do not compare unfavourably with those in other countries. His calculations show that while the American farmer, on the average, gets 42 per cent. of the consumer's dollar, the

Indian farmer obtains, in respect of the commodities surveyed, 50 to 55 per cent. of the price paid by the consumer.

Despite the statistical limitations of the study arising from imperfect data—as admitted by the author himself—the brochure should be welcome to all interested in problems of agricultural marketing, particularly by way of stimulating interest in a subject of growing importance. It is often overlooked that while technological improvements may—and have indeed done—lead to progressive economy and efficiency in production characterized by displacement of persons employed, these have not been followed by any commensurate developments on the distributive side. Detailed figures available for America would make an interesting revelation in this respect: "Between 1870 and 1930 in the U.S.A. the number of workers engaged in distributing goods has kept pace (100 to 877) with the ninefold expansion in physical volume (100 to 910), while the number of workers required in production in 1930 was less than three times (271 per cent.) as great as in 1870." In the United Kingdom also, between 1923 and 1933 the number of workers employed in distributive trade rose from 1,254,000 to 1,992,000.

In making such an objective statistical study, the author has done well in not going into the economic justification or rationale of the present distributive organization in India, as that would involve an immense problem by itself, relating to numerous factors of socio-economic significance. Presumably on this ground, again, he has avoided a correlated study of the producer's prices and his actual costs, for it is obvious that from this standpoint even the same price spread may have entirely different economic significance. In the present conditions of industrial development in India a similar study of price spreads in respect of industrial goods—from the factory to the consumer—appears to be quite as important and urgent for various reasons. Evidently, such an investigation can be undertaken with great advantage by an organization like the *Federation of Indian Chambers of Commerce and Industry*, and it would be well if this subject is also taken up by the Research Department of the *Federation*.

J. N. S. G.

NON-TECHNICAL NOTES

26. MANUFACTURE OF GLANDULAR PRODUCTS

THE manufacture of glandular products can profitably be undertaken in a central factory where products like adrenaline, pituitrin and thyroid extracts can be handled simultaneously. It will be profitable for the existing pharmaceutical concerns to take up the manufacture of glandular products, in which case, the cost of skilled and unskilled labour will be appreciably reduced, thereby reducing the cost of production. It will be more economical if arrangements could be made to pool the gland resources of the major slaughterhouses of the country and to transport them to a central factory for processing. Details relating to the collection and preservation of glands are found in the articles published in the *Journal of Scientific and Industrial Research*, (1944, 2, 83) and *Current Science* (1943, 12, 244, 319).*

An essential prerequisite of the factory for large-scale production of gland products, is a well-equipped bio-assay laboratory, where the finished products could be subjected to the strictest possible test by bio-assay methods, before releasing to the clinician.

The present note is confined to the preparation of three gland products, viz., adrenaline, pituitrin and thyroid extracts.

Adrenaline.—The hormone elaborated by the adrenal medulla is extensively used in medicine and surgery. Prior to the outbreak of the war, India was dependent entirely on European and American firms for the supply of this drug. The natural product prepared from slaughter-house material, can compete

favourably with the synthetic imported product (price of the B.D.H. Product was Rs. 4-8-0 per gm. before the war), and it will be realized that the cost of production can be brought down appreciably by a better organization of slaughter houses, and labour will be cheaper in the post-war period.

The posterior pituitary forms the source of "pituitrin," which is extensively used in clinical practice. The fresh gland can be utilized for the purpose, but more often, a dried powder prepared by desiccating the posterior lobe material is made use of.

Desiccated thyroid is used in cases of thyroid deficiency in the treatment of certain types of obesity and as a general tonic. The thyroid gland of Indian animals contains a very high percentage of thyroxine iodine, so that in order to bring the potency of the powder into line with that of the *British Pharmacopæia*, some diluent has to be added as indicated below in the cost sheet.

Process

Adrenaline.—Isolation from natural sources, i.e., the suprarenal gland of slaughtered animals.—In India, the intermediate fine chemicals needed for the synthesis of adrenaline are not available at the present time and we have, therefore, to depend entirely on our gland resources which, however, are abundant. The process for the isolation of adrenaline consists in extracting the minced glandular tissue with acidified solvents, which may be aqueous or alcoholic, and precipitating the free base from the concentrated extract by the cautious addition of ammonia. The crude adrenaline so obtained is purified by reprecipitation.

Posterior Pituitary.—The fresh gland can be utilized for the purpose, but more often a dried powder is made use of. Fresh ox pituitary is cleaned free from fat and connective tissue; the posterior lobe is then carefully dissected out and dried by repeated charges of a desiccating solvent. The solid obtained is ground to a fine powder and sieved,

Desiccated Thyroid.—The preparation of *Thyroideum Siccum* consists in drying the

*Suggestions contained in the articles include :—

- (i) Freezing the glands immediately after removal from the carcass, either with freezing mixture or preferably with solid carbon dioxide.
- (ii) Processing the thawed glands, without undue delay, for the isolation of active principles.
- (iii) Chilling the glands soon after collection from the slaughtered animals and working them up within 24 hours to give maximum yield of adrenaline.
- (iv) Drying the posterior lobe material and keeping it at low temperature and out of contact with air.
- (v) Drying the thyroid gland at moderate temperature and then defatting for preservation till required for subsequent processing.

glands at a regulated temperature and removing the fat by lipoidal solvents, and adjusting the concentration of the final powder by adding diluents so that the thyroxine iodine content is 0.1 per cent.

Raw Materials

The chief raw materials needed are the animal glands, chemicals and solvents all of which are easily available in the country.

Equipment and Machinery

Almost all the equipment and machinery required can be fabricated in India. The following are the main items :

- (1) Vacuum installation (motor, 5 h.p.), shaft, vacuum pump (capacity 30 cubic feet per minute), pipe-lines, etc.
- (2) Vacuum distillation still (capacity, approx. 10 gallons).
- (3) Vacuum drying oven (capacity, 6 cubic feet).
- (4) Suction draught drier (capacity, 6 cubic feet).
- (5) Extraction vessels (including shaking machine, filtration equipment, etc.).
- (6) Ampoule filling machinery.
- (7) Hot air sterilizer (electrically heated, capacity, about 6 cubic feet).
- (8) Autoclave (capacity, 10 cubic feet).
- (9) Tablet making machine.
- (10) Refrigeration machinery (including cooling cabins, brine circulation units, etc.).
- (11) Volatile solvents recovery plant.
- (12) Mincing machinery.
- (13) Grinding machinery.
- (14) Equipment for bio-assay laboratory.

Cost Sheet

Capital investment..Rs. 1,00,000 (Rupees one lakh).

Composed of Rs. 67,000 for the cost of equipment and Rs. 33,000 for running expenditure required to handle about 3 to 5 kg. of adrenal glands, 2 to 3 kg. of thyroid glands and about 50 to 75 gm. of posterior pituitary tissue per day, which would yield about 5 to 8 gm. of adrenaline, 2 to 4 lbs. of *thyroideum siccum* and about 6 to 10 gm. of posterior pituitary powder per day.

Labour.—The following skilled and unskilled staff will be required for handling the manufacture of all the three drugs in the proportions indicated above.

	Rs.
1. Chemist at Rs. 250 per month ..	250
2. Two Assistant Chemists at Rs. 150 per month ..	300
3. Assaying Chemist at Rs. 250 per month ..	250
4. Three laboratory attendants at Rs. 45 per month each..	135
5. 50 unskilled workers at Re. 1 per man per day ..	1,500
	2,435

Cost of production.—For a dependable estimate, a daily output of roughly 6 gm. of pure adrenaline or 5,000 c.c. adrenaline ampoules of *B.P.* strength; 8 gm. of posterior pituitary powder or 2,100 (approx.) $\frac{1}{2}$ c.c. pituitrin ampoules of *B.P.* strength; and over 30,000 thyroid tablets, is assumed. The estimates are based on pilot plant trials conducted at Madras.

Overall estimate of the prime cost of daily production (inclusive of packing charges).

	Rs.
1. Materials	
(1) Cost of glands ..	40
(2) Cost of chemicals ..	42
(3) Cost of ampoules, phials and packing charges ..	425
2. Cost of electricity and fuel ..	11
3. Labour (skilled and unskilled) ..	81
4. Other miscellaneous items of direct expense ..	29
Total	628

There is a handsome margin between the estimated cost and gross earnings (calculated on pre-war prices) which should suffice to meet the various overhead charges and yet yield a substantial profit. The profits according to this calculation should go higher up with a fall in the prices of chemicals, etc., and reduction in the price of glands with a better organization of the slaughter houses.

Estimates of the prime costs of individual items are given in the appendix.

<i>Quantity and Value (at pre-war prices of imports) of the Daily Output.</i>			
Item.	Daily production (Approx.)	Pre-war price of imports.	Estimated value of daily production (approx.) Rs. a.
Adrenaline ampoules.	5,000 one c.c. of B.P. strength from 6 gms. of pure adrenaline.	B.D.H. Co. price for a box of 12 one c.c. ampoules, Rs. 2-9-10.	1,089-4
Pituitrin ampoules.	1,067 one c.c. from 8 gms. of pituitary powder. Or 2,100 (approx.) $\frac{1}{2}$ c.c. of B.P. strength.	B.D.H. Co. price per box of 12 one c.c. ampoules, Rs. 5/-.	445-0
Thyroid tablets.	30,000 tablets of 0.5 grains.	B.D.H. Co. price per bottle of 100 tablets of 0.5 grains, Rs. 3-11-0.	1,106-4
	Less rejections in testing, 7-8. adrenaline ampoules 3-0. pituitrin ampoules .. 10-8.	Total	2,640-8
			10-8
			2,630-0

APPENDIX.

Estimates of the prime costs of individual gland products.

I. Adrenaline :

- (a) *Adrenaline powder (free base)*—cost of 1.6 gms.—

	Rs. a.
1 kg. of gland tissue	.. 1 8
Labour	.. 3 0
Solvents, chemicals, etc.	.. 2 0
Current, heating material, etc.	.. 0 12
Miscellaneous	.. 0 4
	7 8

- (b) *Adrenaline ampoules*.—Cost of making 1,000 one cc. ampoules of Adrenaline hydrochloride

(B.P. strength) works out approximately as follows :—

	Rs. a.
1.2 gms. of Adrenaline powder	.. 5 10
Chemicals, etc.	.. 3 0
1,000 ampoules	.. 10 0
Labour	.. 5 0
Labelling and packing	.. 25 0
Heating material	.. 1 0
Miscellaneous	.. 3 0
Overall losses due to rejection of certain number of sealed ampoules during testing	.. 1 8
	54 2

II.—Posterior pituitary :

- (a) *Preparation of dry powder*.—The approximate cost of making 1 gm. of the posterior lobe powder is as follows :—

	Rs. a.
Cost of the required quantity of posterior lobe tissue	3 0
Labour	.. 1 0
Chemicals	.. 1 0
Current for heating, etc.	.. 0 4
Miscellaneous	.. 0 4
	5 8

- (b) *Pituitrin ampoules*.—Cost of making 1,000 one cc. ampoules of pituitrin, each cc. containing 10 international units, will be approximately as follows :—

	Rs. a.
7.5 gms. of pituitary powder	.. 41 4
1,000 one cc. ampoules	.. 10 0
Chemicals, etc.	.. 3 0
Labour	.. 5 0
Labelling and packing	.. 25 0
Heating material	.. 2 0
Miscellaneous	.. 3 0
Overall losses due to rejection of certain number of sealed ampoules during testing	.. 3 0
	92 4

III.—Desiccated thyroid (*Thyroideum Siccum B.P.*) :

- (a) *Desiccated thyroid (powder)*.—Cost of making one lb. of desiccated thyroid works out as follows :—

	Rs. a.
Glands	.. 5 0
Labour	.. 4 0
Current, fuel, etc.	.. 1 0
Solvents	.. 4 0
	14 0

Cost of 2 lbs. diluent in order to bring the potency of the powder into line with that of B.P. .. 4 0

Cost of 3 lbs. of *thyroideum siccum* .. 18 0

∴ Cost per lb. .. 6 0

- (b) *Thyroid tablets*.—Cost of making 1,000 tablets (0.5 grains each)—

	Rs. a. p.
35 gms. of thyroid powder	.. 0 7 6
Labour	.. 1 0 0
Bottles	.. 5 0 0
Packing and labelling	.. 2 0 0
Miscellaneous	.. 0 4 0

8 11 6

METHODS OF TESTING FINISHED MOULDINGS*

STANDARD methods for determining performance characteristics of various plastic products have up till now involved the preparation of special test pieces from original moulding powders, on which tests are performed in accordance with agreed methods specified by various authorities, such as the *A.S.T.M.* and *British Standards Institution*. This procedure gives a fair idea of how mouldings made from various moulding powders would behave under service conditions, but it does not take into account the effect of all the variables that play an important part during the conversion of a given moulding powder into the finished articles of commerce. It has long been felt that suitable standard methods should be developed for determining the characteristics of finished moulded articles as supplied to the users. The difficulties that lie in the way of developing such methods become obvious when one considers the numerous shapes and sizes of mouldings that are produced for divers applications. Certain service tests have been adopted for testing mouldings meant for particular applications, but they can hardly be regarded as general enough for standardization purposes. The work reported in the Technical Report, B/T40 of the *British Electrical and Allied Industries Research Association* represents a welcome step in this direction. It demonstrates the enormity of the task which could be tackled only by close collaboration between various interested parties. The work was undertaken at the request of the *British Standards Institution* under the direction of Prof. W. J. John of the Queen Mary College, University of London, by B. C. Flemming-Williams, Z. Rogowsky, D. J. Strong and B. Shearman.

The problem was to develop tests suitable for miniature specimens cut out from finished mouldings. The possibility of correlating such results with those obtained from standard test pieces prescribed by the existing specifications, was considered. It was thought that, whether a direct correlation was found or not, the results would throw some light on the effect of the variables entering into the moulding technique and the mould designs adopted for various purposes. One of the immediate results of this investigation was that in a large proportion of finished mouldings, certain regions, particularly in the thicker sections, remained appreciably under-pressed or under-cured, which sometime lead to a definitely porous structure.

The tests that received detailed attention included: (a) Impact strength; (b) cross-breaking strength; (c) crushing strength; (d) specific gravity; (e) electric strength; (f) surface resistivity; (g) water absorption; (h) plastic yield; (j) heat resistance.

For the purpose of assessing the possibilities of obtaining different sizes of miniature specimens for the tests, the authors developed an ingenious scheme for the examination of a great variety of mouldings, and calculated in detail the percentage of the available mouldings that would be suitable for giving the required sizes of miniature specimens. For this purpose 113 different types of mouldings were actually examined, but they represented a much larger number, so that the authors' conclusions could be regarded as much more generally applicable. The technique of actually cutting and finishing the miniature test specimens received considerable attention. Special jigs and fixtures for holding specimens while they were being worked were developed. Of particular interest in this connection was the fixture for making an accurately semi-circular notch, 0.25 mm. deep in a 10 mm. x 10 mm. x 2 mm. specimen.

In the brief space of this note, it is not possible to describe with any degree of accuracy the details of the new tests developed, or of the adaptations of old tests for the purpose of testing miniature specimens. Though the various parts of the work were apparently conducted over a long period of time and separately reported upon, one of the authors has made an excellent job of collating all the results together in a coherent manner. The results obtained have been summarized in a table which is reproduced below:—

It will be seen that in 5 out of 9 tests, a reasonable or approximate correlation could be established between standard tests and tests on miniature specimens cut from finished mouldings. Although this is a matter for satisfaction, yet the failure to obtain a correlation in the other cases, raises fundamental issues. In fact the rationale of the standard test methods itself becomes questionable. It is, however agreed in general that most of the test methods applied to commercial products have been actually developed for the sake of convenience and expediency. The only reason why really rational methods are not available for all types of standard tests demonstrates our lack of fundamental knowledge as to how a given test result is affected by the size and shape of the test specimen and the variables entering into the methods of test. Take, for instance, the water absorption test. Apart from the fact that little is known about the manner in which the electrical and mechanical properties of plastic mouldings are affected by absorbed water, the mechanism and even the process of absorption has not been fully understood. The present report clearly

* Technical Report B/T40, of the British Electrical and Allied Industries Research Association, London, 1944.

Summary of Results

Property tested	Means or apparatus used.	Size of miniature specimen	Percentage of mouldings from which specimen is obtainable	Remarks	Correlation of results with standard tests
Impact strength.	Dynstat with modified pendulum.	Notched:— 10 × 10 × 2 mm. Unnotched:— 10 × 10 × 2 mm. to 10 × 5 × 1 mm.	63% 63% 97%	Striking distance should be 1.75 times specimen thickness.	No correlation expected or observed.
Cross-breaking strength.	Dynstat (unmodified)	15 × 10 × 4 mm. to 10 × 5 × 1.6 mm. Recommended size: 10 × 5 × 2 mm.	— 66% 63%	Variation is large. Average of a number of tests should be taken.	Cross-breaking strength can be very approximately related to all the dimensions: $C = 6M/bd$. Hence approximate correlation can be obtained.
Crushing strength.	Simple beam-type machine giving load up to 4.5 kg.	3 mm. cube or cylinder.	83%		Approximate correlation is obtained for geometrically similar specimens using formula $Y = y + ny/y'$, if $Y = h/30$, and $n = h/48$, where $h =$ height of specimen in mm.
Electric strength.	Electrodes are a 24 mm. steel ball and a brass plate respectively. A special anti-flashover shield of ebonite is sealed to the specimen.	Disc 8 mm. diameter and up to 1 mm. thick.	85%	Tests may be made, under oil, using shield, if desired.	No correlation expected or observed.
Surface resistivity.	"Aquadag" line electrodes applied with special pen. Metal contact fingers and sensitive ballistic galvanometer.	Surface of actual moulding.	100%	Surface resistivity varies with gap width between electrodes, and variation differs for different materials.	Reasonable correlation within limits of experimental error.
Resistance to heat (glow-bar test).	Glow-bar apparatus.	10 × 15 × 1 mm.	Over 80%	Classification into clearly defined groups reasonably satisfactory.	Since B.S. document give no classification, no correlation was possible.
Plastic yield.	Three-point load apparatus.	5 × 10 × 1.5 mm. or 10 × 10 × 1 mm.	85% 70%	Short time tests (temperature raised at 50° C. per hour) gave rough indication of yield temperature. Long time tests (stress applied at constant temperature) for more accurate work.	Reasonable correlation in short time tests, correlation to within 1° C. in long time tests.
	Vicat needle apparatus.	Disc 8 mm. diameter, 1 mm. thick.	85%		Fair correlation in short time tests, no correlation in long time tests.
Specific gravity.	Direct weighing and computation of dimensions, or weighing in air and in liquid.	Immaterial.	100%		Satisfactory correlation obtained.
Water absorption.	Immersion and constant humidity vessels. Balance.	Strip about 2 cm. × 1 cm. × 0.15 mm. cut as cylindrical shaving from moulding, or powder filed from moulding.	Nearly all mouldings	Tests were made by immersion, by exposure to known R.H., and by exposure of powder to known R.H.	No clear correlation by any method. (Correlation not expected).
			100%		

demonstrates that water absorption figures are not correlated either to the weight or the volume or even the surface area of a test piece. In the circumstance, it is difficult to conceive how a really rational test procedure could be worked out for water absorption and the necessity for depending on arbitrary standards becomes apparent. What has been said about the water absorption tests applies more or less to other tests also. But it is doubtful whether a scientific mind will ever be satisfied with this position. It is reasonable to suppose that more extended and

systematic work, both on the experimental and theoretical aspects of the various problems involved, will lead to useful conclusions.

The authors conclude their report with several suggestions for further work. It is hoped that the work, if pursued, will not only serve to correlate the results of miniature specimen tests with those of standard tests, but also throw more light on the gaps that still exist in our fundamental knowledge regarding the properties of materials in general.

L.C.V.

NOTES AND NEWS

Benzyl Penicillin

ACCORDING to recent investigations conducted in the Laboratories of the Winthrop Chemical Company Inc., New York, the benzyl ester of penicillin—*Benzyl penicillin G.*, is at least three times as potent as ordinary sodium penicillin in aqueous solution or suspended in oil. When taken by mouth the benzyl penicillin is less active than by injection, but still is sufficiently potent to make it substantially as effective as an equivalent weight of sodium penicillin given by subcutaneous injection (*Science* 1945, 102, 150). Benzyl penicillin is a colourless, hard, glassy solid, which promises to be extremely valuable because of its ease of preparation, enhanced stability, ready oral absorption and powerful chemotherapeutic action.

Butyl Alcohol from Waste Sulphite Liquor

A process for the production of butyl alcohol by the fermentation of waste sulphite liquor has been developed by Dr. Bror L. Grondal, University of Washington and Major Henry W. Barger.

Waste sulphite liquor contains about 2 per cent. fermentable sugar. For utilizing the sugar, it is necessary to eliminate the inhibiting materials present in the liquor while retaining the growth-elements necessary for the normal development of *Clostridium acetobutylicum*.

It is known that to produce butyl alcohol in quantity from sulphite liquor, the addition of biotin and other growth promoting factors are essential. In the new process, yeast is actually produced in the medium and this renders the addition of growth-promoting materials unnecessary. From 100 lbs. of sugar in the medium, 22-23 lbs. of butyl alcohol, 10-12 lbs. of acetone, and about 3 lbs. of ethyl alcohol are obtained. A large amount of yeast fodder for livestock is also obtained in this process.

Totaquina from Cinchona Bark

A new process for the extraction of alkaloids from plant materials has been developed by the U.S. War Department (*Chemical Trade Journal*, 1945, 117, 216). The method is based on the principle of acid extraction followed by ion-exchange recovery. The process is being employed for the production of totaquina in the Andes.

The alkaloids are leached out by dilute sulphuric acid from the bark which is placed in a perforated bag. The leachate is pumped into the ion-exchanger, from which it is released in free form by treatment with caustic soda solution, and then extracted by alcohol. The overall efficiency of the process is estimated at 80 per cent., and the costs of production are said to be considerably lower than that by the conventional method. Information relating to the nature of the ion exchange material has not so far been made public.

Calcium Cyanamide

A new method which holds out promise for the manufacture of calcium cyanamide without the intermediate production of calcium carbide has been developed by Nagai and Yamaguchi of the University of Tokyo (*Chem. Trade J.*, 1945, 117, 260). The method consists in treating calcium carbo-

nate or a mixture of calcium and magnesium carbonates at high temperatures with a mixture of ammonia and carbon dioxide.

When finally powdered calcspar is allowed to react at 800° C. with a mixture of 95 per cent. ammonia, and 5 per cent. carbon dioxide, a cyanamide yield of 92-94 per cent. is obtained. With ordinary ground limestone, the yields were lower, due presumably to the presence of iron oxide, which catalytically decomposes ammonia into nitrogen and hydrogen. The effect of iron can be masked either by the addition of calcium sulphate or calcium sulphite to the limestone or by the addition of small quantities of carbon bisulphide or hydrogen sulphide to the gas mixture used in the reaction.

N.D.G.A. Food Preservative

Researches carried out by Prof. Bieter of the University of Minnesota have revealed that extracts of the common desert plant, *Larrea divaricata*, are highly antiseptic. The active principle of the plant is nordihydroguaiaretic acid (N.D.G.A.). Further investigations have shown that N.D.G.A. has pronounced anti-oxidant properties for fats and oils and generally for food products. The commercial production was started by *Wm. J. Strange Co.* in 1944 and the entire output of the factory was being used during the war, for food products required by the armed forces. It is one of the best agents known for preserving the flavour and sweetness of fats, and oils (*Ind. Eng. Chem., Ind. Edn.* 1945, 37, No. 8, *Rpts. on Chem. World.*, p. 14). It is used in concentration of 0.01 per cent. The use patents for this product are public, being issued by the U.S. Department of Agriculture.

"Capaloy" for Laboratory Ware

A new material designated "Capaloy Platinum," useful for making crucibles and other articles now made of platinum alone, has been developed in America. It is an alloy of all the members of the platinum family. The new product, developed because of war necessity and now thoroughly tested in actual use, is claimed to be superior to the platinum ware. It is a product of the *Oscap Manufacturing Company*, and has been tested over months in Army, industrial and university chemical laboratories, and found satisfactory. The colour of the new material is the silver grey of platinum, but slightly darker. It is non-oxidizable, has high tensile strength and flexibility, and is resistant to all acids except boiling *aqua regia*. (*Science*, 1945, 102, No. 2642, *Suppl.* page 10). It has to be used with the same precautions as any platinum ware, namely "not for the ignition of phosphates or arsenates, not for the reduction of easily fused metals such as lead, etc."

A New Variety of Cotton

A new variety of cotton has been evolved by the treatment of cotton seed with X-rays, and large-scale field trials during the last two years have confirmed its uniform superiority over the untreated control. It has a greater fibre length and has proved prolific, in that its yield is either the same or in some years better than the control, but never less.

Experiments carried out at the *Institute of Plant Industry, Indore*, showed that variability for ginning

percentage was much greater in the treated progenies than in the control, and it was possible to select from among the treated seeds individuals having a higher ginning percentage. The behaviour of these selected progenies has been consistent from year to year.

Sugar Beet in Peshawar

The agricultural prospects for beet cultivation and sugar manufacture are satisfactory in the Peshawar Valley. This has been established by a series of trials, carried out by the Director of Agriculture and the Sugarcane Specialist of the North West Frontier Province, the results of which have been reported in *Indian Farming* (1945, 6, 57). The first tests were started in 1912-13. Dr. Leather reported that the roots of the crop could be grown to "great perfection" in the neighbourhood of Peshawar. Systematic trials on three outstanding varieties were begun in 1935-36, and continued for five years. These trials have shown that while *vilmorin* yielded the highest tonnage per acre, *z.z. German* had a high record for juice quality.

It is pointed out that the harvesting season, when profitable recovery may be obtained, extends from the last week of April to the beginning of September, a period during which sugar factories working with sugarcane as raw material are usually idle. During this period, part of the machinery can be switched on to the manufacture of sugar from beet. The extra cost for combining the sugar beet machinery with a 400-ton sugarcane plant is estimated at Rs. 4 lakhs. A working of sugar factories with both sugarcane and beet as raw materials should prove to be an important development in the Indian sugar industry.

Laminated Skis

Till recently *skis* used in this country were mostly imported from abroad, the *skis* being usually made of ash or hickory. With the advent of war, imports of foreign *skis* almost stopped while the demand increased, as they were also required by the Defence Services. To meet this demand, experiments were carried out at the *Forest Research Institute*, Dehra Dun, on the production of laminated *skis* with considerable success.

The results of the experiments on the fabrication of laminated *skis* show that laminated *skis* made from *Dalbergia sissoo* and *Artocarpus hirsuta* using water resistant phenolic adhesives were not only satisfactory, but superior to solid wood *skis* in many respects.

In view of the encouraging results obtained, it is hoped that production of laminated *skis* from Indian timbers will be taken up by firms manufacturing sporting materials.

Shellac Varnish

Replaced by synthetics in a number of applications, shellac is still dominant in three fields—floor varnish, sound records and electrical installations. Even in these fields, inroads have been made by such materials like vinyl resins which were permitted for radio transcriptions when shellac supplies were short (*Ind. & Eng. Chem.*, 1945, 37, No. 9, *Rpts. on the Chem. World*, p. 1).

The search for shellac substitutes was intensified by war shortages. In the field of varnishes, resin compositions of the maleic, phthalic or phenolic types and even zein have been employed. The experience with synthetics has indicated the possibilities of modifying shellac varnish through formulation. The need for intensifying research is clear. The bulk

of research in America was sponsored by the *Shellac Manufacturers' Association*, but this was discontinued in 1942. Facilities for research in industry is limited and unless the research programme of the *Shellac Importers' Association* is resumed, research will be largely in the hands of users, and may tend to emphasize its utilization as a chemical raw material expanding or replacing its traditional use as a resin.

Sugar Manufacture by Open-pan System

Improved plants and processes for the manufacture of sugar by open-pan system, whereby higher recovery and better quality of sugar can be obtained, have been evolved by the Sugar Research and Testing Station, Bilari, District Moradabad.

It is proposed to work the improved plants and processes side by side with the indigenous plants and processes, during the season 1945-46 in collaboration with *khandsaris* or owners of farms and open-pan factories. The scientific and commercial data so collected will be of considerable value in planning further research and development.

Industrial Uses of Barley

The manufacture of malt extracts and other malt products from barley is practically non-existent in this country and appears to be a promising line of development. The brewing industry should also be developed on sound lines so that after the war it may not suffer from foreign competition. The development of the brewing industry in India will provide a good market for the better quality barley. There is also scope for improving and expanding the manufacture of pearl barley and barley powder in this country," states the *Report on the Marketing of Barley in India*, published by the Central Agricultural Marketing Department of the Government of India.

That Indian barley is of good malting quality has been established by the tests conducted at the *Institute of Brewing, London*. "But these experiments were mainly on a laboratory scale, and it will, therefore, be necessary to find out by means of trials on a commercial scale whether Indian barley would satisfy the quality requirements of the British brewer. This should be done as soon as possible," states the *Report*, "by sending experimental consignments to that country." Several tests on the malting qualities of barley have been carried out at the *Imperial Agricultural Research Institute, Delhi*, and also at the *Indian Institute of Science, Bangalore*.

In many countries, barley is still an important article of human diet. For instance, in Japan, this cereal takes second place to rice as food, and in India, Tibet and some parts of Europe it is the chief subsistence food of poor people. Pearl barley and barley powder, products of barley grain from which the fibrous integuments have been removed, are easy of digestion and possess demulcent properties, and are, for that reason, much used in the dietary of the sick. These products are also employed in the preparation of soups in European cookery.

As livestock feed, barley is comparatively important in European countries and America and most of the international trade in this grain consists of the feeding quality meant for the hog as well as cattle.

The average yield per acre of barley in India works out, according to the *Report*, to 802 lbs., which is low in comparison with most other barley producing countries of the world.

The *Report* recommends the establishment of regulated markets and invites consideration of the

transport authorities to accord a suitable reduction in the freight rates of barley as compared to wheat, in so far as the former (barley) is normally a cheaper grain than the latter (wheat).

Cultivation and Marketing of Bengal Gram

Gram or *Bengal gram* (*Cicer arietenum*), like oats elsewhere, forms an important food crop both for men and farmstock. It takes the fourth place in acreage (18 million acres) and production (4.4 million tons) among the foodgrains of the country, and the sixth place in value.

The *Report on the Marketing of Gram*, recently issued by the Agricultural Marketing Department of the Government of India, provides valuable information on gram production and trade. The average yield per acre of gram in India during the ten years ending 1939 was 503 lbs. This, according to the *Report*, is low and can be increased by growing high yielding varieties which will also improve the quality of gram. It is suggested that high yielding and better quality varieties evolved by the *Imperial Agricultural Research Institute, Pusa*, and the *Punjab Agricultural Department*, should be popularized among the cultivators who may be induced to replace the indigenous, poor yielding and inferior strains.

The *Report* recommends the development of co-operative marketing of gram in the main producing areas in order to enable the producer to get a fair return. Market charges should also be regulated and standardized and efforts made to introduce a standard contract for trade in gram on the return of normal conditions.

Potential Uses for Electronic Devices

A comprehensive survey has been made by the research department of the *McGraw-Hill Publishing Co., Inc., New York City*, to determine not only the present, but also the potential applications of electronic equipment as envisaged by industry itself.

An equipment manufacturer reports as follows: "Our problems relate to dielectric heating as an improved means over oven (or conduction) heating. We are working on the development of a plastic molding process. This process is for the molding by injection of large articles (5 lbs. and over) of either thermoplastic or thermosetting materials. We have met with a fair measure of success so far. Some of our trials have already involved the use of a 3-kw. Megatherm unit, which was available for these tests. The 7-kw. machine is being installed to carry on these tests and to enable us to broaden our experimental scope. In general, we have learned that we can do certain jobs in minutes which under previous conditions, without the dielectric heater, took as many hours. Since our larger units will soon be ready, we fully expect to handle a wide variety of materials with good results."

A number of suggestions were made concerning the dielectric heating of sheet material. These include curing of resins, sheet plastic, sheet rubber and other similar materials. A paper manufacturer, however, wants to dry bulk paper. "We have tried to get information and results of experience in electronic heating with the object of drying wet paper in roll form, with the hope that the resulting product might resemble air-dried paper (as compared to paper dried under tension on ordinary steam dryers). However, the cost seemed out of sight." From the various comments there appears to be a considerable field in the application of electronic devices in heating, curing and drying.

The problems of welding glass pipe is brought up by a manufacturer of heavy chemicals, but this can well apply to any user of such materials of construction. "Because there is no well developed method of field welding glass pipe, it is necessary to order glass pipe in prefabricated sections and join them with flanges. This method is expensive, requires the preparation of numerous detailed drawings, requires many unsatisfactory joints with gaskets to cause delay when a piece is broken."

A condensed-milk manufacturer offers the following, but similar problems appear in various phases of the chemical industry. "In continuous vacuum pan operation on evaporated milk, an electronic device that would measure the density of the milk and regulate the discharge pump and the milk intake would do the industry a great service. The operation at present is manual and most pan operators tend to over-evaporate with a resulting waste of time and power. We need a device which will register the change in concentration of milk in the pan with the reading visible to the operator at all times."

A manufacturer of high-grade fertilizer would like "some method in the manufacture of super-phosphate which will keep the proportion of sulphuric acid to dust at exactly the same point. Perhaps this can be accomplished by some control operated by the weight of the dust and operating a valve controlling the quantity of sulphuric acid discharged into the mixture." Undoubtedly there are many other similar problems throughout the chemical industry wherein better proportioning methods could be used to great advantage.

Conductivity of various chemical solutions could also be used in a better form of control than presently available. A pulp manufacturer offered this problem in cooking liquor preparation. "By electronics, we wish to magnify the minute current that can be passed by the conductivity of sulphite liquor in its various stages of conductivity. By this means we wish to control the opening and closing of 4" valves to the liquor line." To a manufacturer of aluminium and potassium sulphate a similar problem exists. "We need a photoelectric colorimeter for plant solutions; a simple photoelectric unit could be devised whereby plant solutions could be controlled for such impurities as iron. Said tests would be conducted by plant operators unfamiliar with chemical technique. Such apparatus must be rugged and should utilize an electronic galvanometer." Also, a conductivity method of filter washing control is suggested. "In a circuit where soluble K_2SO_4 is separated from insoluble Al_2O_3 , the filter washing could be controlled and measured by an electronic conductivity apparatus, the conductivity of the filter cake being measured."

Flow measurement of gases could be improved according to a manufacturer of heavy chemicals. "Flow measurement of gases by the use of electronics would perhaps result in more flexibility of application and accuracy. There is at present a need for a temperature and pressure compensating flow water for use on gas measurements. If the variables, pressure differential, pressure and temperature, can be interpreted in electric units, they can be integrated and read as flow. Electronic amplifiers will be necessary for this integration of variables."

Moisture measurement also comes in for suggested improvements. In the manufacture of lightweight, fireproof asbestos sheeting, an electronic device could be used for "moisture-content determination,

either as a separate testing device or to signal when the product being even dried has reached the proper state of dryness." This would save redrying, increase dryer capacity by shortening drying time allowance, and also save fuel. Most drying cycles are set longer than necessary to prevent need for redrying.

Though no present applications for supersonic or molecular vibration devices were reported in this survey some potential applications were suggested. These included the following: "Removal of sludge accumulation from crude oil transports such as barges and tanks by emulsification through molecular vibration, whereby the emulsion so formed may be readily removed by pumping." Also, "Use of supersonics in liquids to hasten chemical reaction; in our case it might be possible to increase production and quality by 50 per cent. with no additional equipment, except a supersonic agitator to augment the mechanical agitation. Reaction is one of simple solution complicated by floc formation." There is no doubt that molecular-vibration devices will find some usefulness in the chemical industry, provided they are rugged, reliable and not excessive in price.—(*Chemical & Metallurgical Engineering*, June 1945), U.S.I.S.

Soil Conservation Work in Australia

As part of the Australian campaign to combat soil erosion, a full-scale offensive against this menace is to begin in New South Wales. The co-operation of every landowner will be sought.

In preparation for the campaign, officers of the Soil Conservation Service and the Department of Agriculture held special schools for farmers recently at Camden and Cawra.

The Soil Conservation Service in New South Wales was initiated in 1937, and although the war has retarded its progress, it has established stations at a number of centres. Considerable research has been carried out and control projects instituted on private holdings.

A widespread educational campaign is being prepared in which anti-erosion measures will be taught in schools, high schools, colleges and universities.

Export Trade in Hides and Skins

With the end of hostilities, it is understood that the desirability of liberalizing the control on exports of hides and skins is being urged by the commercial community.

There is at present a virtual prohibition on the exports of heavier raw hides. Only such quantities of lightweight cow hides are permitted to be exported as are surplus to internal requirements.

India is one of the important producers of hides and skins. In normal times, there had always been some surplus of these products for export. During the war, however, the export of heavier hides had to be stopped in order to enable them to be utilized for the war effort.

Under the existing regulations, export of only lightweight cow hides is permissible to the U.K. and the U.S.A., provided the hides intended for export have been first offered and rejected by Indian tanners. In this way, priority is given to internal requirements.

A limited quantity of light cow hides is also permitted to be exported to Turkey, which was one of the outlets for the exportable surplus of Indian raw hides in normal times.

The whole question is understood to be under examination in the Commerce Department in the light of the changed circumstances as a result of the termination of the war.

Engineering and Chemical Panels

During his recent visit to America, the Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, is understood to have made arrangements with two firms to send their experts to India mainly for the purpose of advising the Engineering and Chemical Panels of the Planning and Development Department.

The firms in question are Messrs. Ford, Bacon and Davis, the famous firm of Consulting Engineers in the United States who have advised the Government of Russia and several South American States, and the Chemical Construction Corporation. An expert from the latter firm has already arrived in India.

All-India Manufacturers' Organization

In his address to the Central Committee of the All-India Manufacturers' Organization (16th September, 1945), Sir M. Visvesvaraya, referred, among other problems, to the question of machinery manufacture. He said:

"The proper thing to do if capital goods cannot be obtained in the near future from Europe and America is to begin to manufacture heavy machinery and machine tools on a large scale, in one or two business centres within the country itself. I have visited factories and workshops in several parts of India in which small size intricate machinery and machine tools and parts are being produced to replace articles which were supplied by foreign imports before the war. Such parts are being made not only for local consumption but are being sent to distant places within the country.

"I have also some knowledge of machine manufacturing industries which I have seen in cities like Detroit and Berlin. The manufacturing of large-size machinery is not attempted in India, not because people are unwilling to take risks, not because of lack of capable men to direct operations, but because of the fear that after the war the products may not be protected from foreign competition.

"We have been importing capital goods for over 50 years. If this country does not even now attempt to build machinery or machine tools for itself as the United States of America and Russia have done in the past with the co-operation of their Governments, we may go on importing capital goods for all time. To succeed in this attempt, however, the co-operation of Government and of more than one large indigenous firm or establishment will be necessary."

International Opium Convention

The U. S. Government on 13th August called on all poppy growing nations to enter into an international agreement which would reduce the production of opium to the medical and scientific needs of the world. The total estimated annual world production of opium amounts to 2,647 tons. It is estimated that after the war the annual needs for medical purposes will not exceed 440 tons. Despite war-time restrictions on international shipping, says the *Bureau of Narcotics*, smugglers were successful in sending from India to America in November 1944 the largest single seizure of opium made by U. S. Customs officers in the past six years. Owing to dis-

organization incident to the war and the relaxation of controls, addition to dangerous drugs is reported to be spreading in many parts of the world.

Agar Control Removed

By a notification published in the *Gazette of India*, dated 29th September, 1945, the Government of India have cancelled the Agar Control Order, 1942, which was introduced to ensure that available supplies of Agar were used only for bacteriological purposes.

The Control has been in existence for over three years and with the cessation of hostilities the necessity for its continuance no longer exists.

Stearic Acid Control Order

By a notification in the *Gazette of India*, (5th October, 1945), the Central Government have cancelled the Stearic Acid Control Order, which has been in force since September, 1944.

Ethylene Dichloride Fumigant

To meet the demand for a non-inflammable fumigant nearly twenty years ago the U. S. Department of Agriculture devised a mixture of 75 per cent. ethylene dichloride with 25 per cent. carbon tetrachloride. There have been considerable advances in fumigation theory and practice since that time, but this fumigant is still widely used throughout the world, specially for bulk grain in small bins and for dried fruits. Chiefly on the grounds of availability and non-inflammability it was recommended for use in the Middle East by the U. K. Authorities in 1942 and arrangements were made for supplies. Similar arrangements have now been made for supplies to India. The first two consignments have arrived and sufficient additional supplies are expected to meet all anticipated demands for 1945.

All orders for the fumigant should be addressed to the Director of Storage, Government of India, Department of Food, New Delhi, who will allocate according to available supplies.

The handling and application of the fumigant are quite simple but should not be left to unskilled labour. The personal supervision of the Officer-in-charge of Fumigation is essential. The vapour of the fumigant is not highly toxic, but it resembles chloroform in that the inhaling of high concentrations will render one unconscious. Well ventilated premises and care against spillage are, therefore, necessary. Prolonged exposure even to small amounts of vapour must also be avoided. The recommendations for fumigation and the procedure are detailed in the publication, *Principles of Cereal Storage* (Manager of Publications, Delhi). These recommendations should be studied carefully and should be fully understood before any fumigation is attempted. Advice on any particular aspect is available on application to Food Department, Government of India.

Food Industries

The *Central Food Advisory Council*, at its meeting held on 15th September in New Delhi, discussed the development of food industries and adopted the following resolution:—

"This Council recognizes the importance of processed food industries in the economy of the country and recommends that the development made during the war should be maintained and progressed in the interests of conservation of food-stuffs, general nutrition and industrialization of the country."

British Cotton Industry Research Association Fellowships

The Council of the *British Cotton Industry Research Association* has announced its decision to award, annually, a limited number of Fellowships with the object of training young men in research methods in pure science, and particularly those branches of prime interest to the Association. The Association conducts researches on the utilization of cotton, rayon, silk and synthetic fibres. The Fellowships will be open to graduates of British nationality and will be tenable at any British University. The value of the Fellowship will not be less than £200 per annum. There will be no restriction of any type on the academic freedom of the holder of the Fellowship.

It was not long ago that the *Imperial Chemical Industries* announced their generous scheme for the award of Research Fellowships in British Universities, a scheme which has since been extended to Indian Universities. The example set by I.C.I. and the *Cotton Industry Research Association* is worthy of emulation by industrial organizations in India. The award acknowledges the importance of pure research for the progress of industry, and the absence of any type of restrictive interference with the research work of the Fellowship holder, provides the necessary freedom for the progress of academic research. In India, there have been many shining examples of wealth aiding knowledge, and now that the rôle of science in industrial advancement has received wide and ample recognition, it is to be hoped that industrialists and industrial associations would come forward with generous donations for the promotion of basic scientific research.

Famine Commission Report

It is reliably learnt that Sir Clarence Bird, Regional Food Commissioner, North-Western Region, has been appointed Special Officer in the Central Food Department to implement the recommendations of the Famine Commission Report. His duties, *inter alia*, will be to co-ordinate activities of the several Departments of the Government of India as well as of various Provincial Governments in the light of the recommendations made in the final Report of the Famine Commission.

Dictionary of Economic Products and Industrial Resources of India

The following articles have been received from external contributors during the month of September 1945:—

Botany

Areca catechu.—(A. K. Yegna Narayan Iyer).
Cardamom.—(W. W. Mayne).

Announcements

Dr. S. Parthasarathy has been deputed by the Government of India to Japan to study the scientific aspects of the damage caused by atomic bombs. He left Delhi early November.

Prof. J. N. Mukherjee, D.Sc., F.N.I., C.B.E., Ghosh Professor of Chemistry, University College of Science, Calcutta, has been appointed Director, Imperial Agricultural Research Institute, Delhi, in succession to Rao Bahadur Dr. B. Vishvanath. Prof. Mukherjee assumed charge of his duties on 15th November.

Reports from States and Provinces

Mysore

Economic Minerals

THE recent issue of the *Records of the Mysore Geological Department* (Vol. XLII, 1943) contains, in addition to the Director's Annual Report for 1942-43, some interesting papers on the economic minerals of the State. Investigations by Messrs. Venugopal and Ram Rao on the utilization of the earth-soda deposits of the Mysore District for the extraction of soda, show that by washing 1 ton of earth-soda, which occurs as an efflorescent deposit in different patches or bands at Dodmola near Chamarajanagar, it is possible to recover 200 lbs. of soda (i.e., a little less than 9 per cent.). The total quantity of earth-soda available in this and neighbouring deposits is estimated at 500 tons a year, and it should be possible to recover 40-50 tons of soda annually, which can be used by the local textile mills, glass and enamel works and the Government dichromate factory. It is proposed to start the extraction on a cottage industry basis in this area.

The occurrence of "Silver Sand" (pure white finely granular quartz) occurring as a disintegration product of a friable quartzite in the Tumkur District has been described in the *Records*. The sand being pure (SiO_2 , 99-98 per cent.) and of more or less equigranular dimensions, it is specially suited for the production of fused silica ware. Other uses for the sand are: in agriculture for opening up heavy soils, in glass manufacture and as a coarse abrasive.

The Mysore Geological Department is probably the first institution in India which has actually started carrying out geophysical surveys of the mineral deposits. As a result of a survey by the Spontaneous Polarization method, carried out by Mr. Rao, a new well-defined body of graphitic schist was located at a depth of 12' beneath the surface in the Ganachar-pur-graphite area of the Kolar District.

The scope for developing the china-clay industry in Malnad has been discussed by Mr. B. N. Rao, in a pamphlet issued by the Department (*Popular Studies*, No. 4, 1945). The total reserves of the deposits occurring in Malnad, especially in the Thirthahalli, Sagar, Koppa, Sringeri and Narasimharajapura taluks is estimated to be about half a million tons of kaolin. Of this amount, the deposits in the neighbourhood of Thirthahalli may yield about 25,000 tons. Levigation experiments have shown that most of the mica and fine grit can be removed by treating the clay in a suitably designed washing plant with small quantities of sodium carbonate or sodium hydroxide. The cost of washing, including that of pigment and chemicals used, is about Re. 1 to Rs. 1-8 per ton of raw kaolin. The yield of refined china-clay is about 20-25 per cent. The washed clays compare favourably in chemical and physical characteristics, with English, American and other Indian clays used by the textile and paper mills in India. They have been found to be quite suitable as fillers in the paper and textile industries. It is suggested that a small porcelain factory should be started to utilize these clays. In course of time the factory may be developed

to undertake the manufacture of hygienic and sanitary wares, glazed tiles, refractories, furnace facings and linings, cupolas, glass melting pots, crucibles, etc. N. L. S.

Government Industrial and Testing Laboratory

Among the many industries which have been developed in Mysore during recent years, the pharmaceutical industry is not as widely known as it deserves to be. The State abounds in a variety of soil and climatic conditions offering excellent facilities for the cultivation of several medicinal plants and herbs. The importance of growing indigenous medicinal plants, manufacture of medicines of standard quality and potency, and their distribution at as low a price as possible, are factors intimately bound with the public health of the State and the country at large.

In 1929, a small laboratory was started as an adjunct to the *Government Soap Factory, Bangalore*, mainly with the object of manufacturing and supplying various medicines required to the *Government Medical Stores* and to the State hospitals. Under the patronage of the Government, the activities of the laboratory steadily expanded. The present *Government Industrial and Testing Laboratory* was founded early in 1931, as an independent institution, not only to increase the manufacture and supply of medicines but also to serve as a test house for the *Government Stores Purchase Committee* and for private industrialists. The *Laboratory* was also to be the nucleus of a research institution to investigate, utilize and develop the resources of the State and help start major and cottage industries.

The *Government Industrial and Testing Laboratory* is well equipped with modern chemical plant and machinery; indeed, some of these—fabricated in stainless steel, monel metal or glass-lined—are designed for highly specialized work. Every opportunity has been availed of to design and fabricate equipment locally; and these have proved to be economical and efficient. A fully equipped control laboratory is also attached to the factory.

All manufacturing operations are conducted under scientific control by skilled workers especially trained. Careful selection of raw materials, strict supervision at every stage of manufacture, and rigid analytical control ensure that every product offered by the factory comes up to the highest standards of purity, potency and uniformity. The products have acquired a reputation for quality, and in many cases, they hold an exclusive field.

The *Laboratory* has made rapid progress within the past few years. Galenicals, medicinal specialties, fine chemicals, glandular extracts and injectables are all manufactured in the factory. Of the many investigations successfully carried out, mention may be made of the production of calcium lactate and gluconate. A considerable amount of work has been carried out on the synthesis of phenol on a pilot plant scale.

During the war, the *Laboratory* availed itself of every opportunity to meet the requirements of the Supply Department, Government of India, and in the

case of products like methanol (acetone-free), amyl nitrite, etc. effected supplies of the total requirements.

With a view to help progress of the institution, Government, in pursuance of their policy to transfer industrial concerns started by them, after they have been established on a sound basis to private enterprise, have ordered the transfer of the *Laboratory* into a joint-stock company with an authorized capital of Rs. 30 lakhs. (Contributed.)

Holkar State—Indore

Cottage Industries

At the meeting of the Cottage Industry Sub-Committee of the Economic Development Board held on 4th August, it was decided to recommend to the Government, the appointment of a whole-time Industrial Survey Officer for Cottage Industries in the State, with a view to the formulation of a plan for the development of cottage industries. The Committee reviewed the arrangements made by the State for supply of yarn to the weavers at Maheshwar, and recommended the starting of a Central Yarn and Colour Depot by the State at Indore.

At a meeting of the Industrial Research Sub-Committee of the Economic Development Board, which took place on the 6th September, it was resolved to recommend to the Government the starting of a mulberry plantation on a plot 4 acres in extent, near Yeshwant Sagar Dak Bungalow as the first preliminary to investigate the possibilities of establishing a sericulture industry, for which the climatic conditions in the Holkar State have been declared by competent experts to be suitable. Cigarette tobacco being another commercial crop that could thrive on the light soils of Mahidpur, Nimar, the Committee recommended the establishment of a co-operative organization of tobacco growers, which would not only supply good seedlings but also purchase green leaves, cure and market the produce. The Committee also discussed the possibilities for the utilization of dolomite, and made recommendations for the commercial exploitation of the large deposits occurring in the State. (Contributed.)

Jammu and Kashmir

Industrial Exhibition, Srinagar

The year's Industrial Exhibition, 16th in number, was opened by Shree Yuvraj Karan Singh Ji Bahadur on the 27th August 1945. The Exhibition buildings, which are a permanent feature, are designed on proper architectural lines and lovely lawns with flower beds, fountains, etc., have been laid out.

Out of the 250 stalls in the Exhibition grounds, 20 were occupied by the Government Departments. Textiles occupy 125 stalls, jewellery, etc., 37, wood carving and papier mache 29, furs 10 and willow works 6. Demonstrations were arranged in paper making, wood carving, stone work, embroidery, pashmina weaving and namda making. The Sericulture Department arranged demonstration of silk reeling. The Mineral Section presented a fine collection of the State's mineral resources. (Contributed.)

Ceylon

COLOMBO,

1st October 1945

The Fisheries Department has launched its long-awaited scheme of trawler fishing in the deep sea.

"Raglan Castle," the second-hand trawler purchased by the Department from the U.K., has after elaborate re-equipment gone into the sea. The capacity of the trawler is said to be adequate for hauling sufficient fish to meet the entire daily demand of Colombo. Its usefulness is said to be limited by the fact that it is not possible for the trawler to return with an appreciable catch more frequently than once a week. It is proposed to can on board the vessel the major fraction of the trawler's catch in order to eliminate waste.

The attention of the public has been drawn by the Government to the facilities provided for long-term agriculture and industry by the *Agricultural and Industrial Credit Corporation of Ceylon*, functioning under the Ministry of Labour, Industry and Commerce. The Corporation helps to wipe off agricultural and industrial debt and finances new agricultural and industrial enterprises. The *Credit Corporation* requires borrowers to give security by a primary mortgage of movable or immovable property in Ceylon, and this stipulation, it is feared, will stand in the way of enterprising science graduates and others without financial backing, from getting any assistance from the Corporation for starting new ventures. The rate of interest charged on the loan is 4½ to 6 per cent.

The Hon'ble G. C. S. Corea, Minister of Labour, Industry and Commerce, expounded the five-year Balfour Industrial Plan of the Government during a recent debate in the State Council. One of the chief features of the plan was the provision of increased research facilities by an expansion of the Industrial Research Laboratory. Protection was to be provided for local industries in four ways: by manipulation of tariff, by a quota system, by a licensing system and by subsidies. Fifty persons were to be trained each year at Government expense in higher and lower technology. The Minister stated that among all the factories sponsored by the Government, the ceramic factory alone failed to fulfil expectations. He also revealed that a scheme for the extraction of iron from the local ilmenite sand had received approval in England. Coming to his own Department's researches, he expressed satisfaction with the success of experiments on the preparation of condensed coconut milk, a scheme which deserved the attention of private financiers. The question of a Government tyre factory drawing upon the enormous rubber output of the island, had been considered, he added. But as the smallest economic unit of production would flood the island with surplus tyres after a fortnight's operation, and as one could not count on an export market in this commodity, the scheme had to be dropped. But the most ambitious project on which he dwelt at length was the establishment of a Central Workshop for the manufacture of plant and machinery required both for the maintenance of existing factories and for Government's new ventures.

The latest news from London regarding "tablet tea" is depressing. The samples sent by the *Tea Research Institute* were tested and examined by a jury of blenders and dealers of the *Tea Buyers' Association*, and also formed the subject of a lengthy report from the *Tea Brokers' Association of London*. The brokers foresee a considerably lower price for the compressed tea, and "it then becomes a question whether saving in cost of manufacture is sufficient to offset depreciation in price." The brokers opine that the new tea would be of value for special purposes, such as on the battle-front.

S. R. K. M.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for August/September, 1945.]

30967. MULTIPLE MOULD CENTRIFUGAL CASTING APPARATUS: *A plurality of superposed mould units, a sprue extending through them and gate cavities connecting the sprue directly with adjacent casting cavities.*—Ford Motor Co. of Canada Ltd.
31208. DETERMINATION OF FAT IN MILK: *Partitioned metallic case for use as water bath and accommodating thermometer and butyrometers.*—Kothavalla.
31320. COMPOSITION FOR APPLICATION TO PLANTS FOR INCREASING THE CROP VALUE: *Applying to the leaves a mixture of a defoliant together with a hygroscopic agent and/or a wetting agent.*—American Cyanamid Co.
31615. MECHANISM FOR TRANSMITTING LINEAR OR ROTARY MOVEMENT: *At each end of each sheath the series of alternating balls and distance pieces, operatively connected to a lever pivoted in a casing.*—Hewitt.
31671. LAMINATED STRUCTURAL MATERIALS SUCH AS PLYWOOD: *Alternate layers of wood and glass fibres permanently united to form an integral unit.*—DePenning.
31785. WHEEL-OPERATED MEANS FOR THE DETECTION OF RAILWAY VEHICLES: *At least two elongated members juxtaposed and rigidly connected together with resilient support and electrical operation.*—Metropolitan-Vickers-Grs. Limited.
31799. CONTROL OF RAILWAY AND OTHER TRACK VEHICLES: *Adaptation of system of counting wheel-axles passing a given location and arrangement in effecting the control of railway or other traffic.*—Metropolitan-Vickers-Grs. Limited.
31878. ELECTRIC MOTOR EQUIPMENTS PROVIDING FIELD WEAKENING OPERATION: *Field excitation of electric motor made dependent on the armature current, excitation reduced during free running operation to obtain higher speeds of the equipments.*—Metropolitan-Vickers Electrical Co., Ltd.
31985. AMIDINES: *Reacting a nitrile with an ammonium salt of a sulphonic acid.*—Boots Pure Drug Co., Ltd.
32327. PLANING THE BLADES OF HAIR CLIPPERS: *Machine comprising a wheel with means for adjusting position and angle of blade.*—Ray Choudhury.
32329. FERTILIZERS: *Digestion of bones, and phosphatic nodules with nitric acid.*—Chand.
32479. ELECTRIC TREATMENT OF MATERIALS: *Material mounted between concentric conductors having concentric transmission line characteristic and radio frequency field applied through them.*—Radio Corp of America.
32492. KEY LOCKS: *Bolt is shot and retracted by energisation of two electromagnetic solenoids wound in opposite directions.*—Brown and Brown.
30283. AIRCRAFT WINGS AND OTHER CONTROL SURFACES OF THE STRESSED-SKIN TYPE: *Articulated inter-section bracing members and operating members operable from outside of wing structure.*—Vickers-Armstrongs Limited.
31234. AIRCRAFT LANDING GEAR: *Endless track unit suspended from articulated under-carriage structure of aircraft and having shock absorbing means.*—Firestone Tire & Rubber Co.
31407. ENDLESS BANDS OR BELTS: *A length of tape or cord is first prepared in braiding machine, its free end is brought between the braiding threads and additional braiding continued.*—Singh.
31562. RETREATING OF TYRES: *Chamber and tyre combine to form a vulcanising chamber about at least the tread portion of the tyre with fluid pressure seal bet tyre and chamber.*—Union Rubber Works Limited and J. A. W. Llewellyn.
31756. AMMONIUM SULPHATE: *Pumping into water ammonia and sulphur dioxide in the presence of a catalyst.*—Chand.
31876. MAINTAINING CONSTANT DIFFERENTIAL PRESSURE ON VALVES, PARTICULARLY FOR USE IN THE GRAVITY DOSING OF CHEMICAL SOLUTIONS: *A miniature weir or knife edge incorporated in a float placed in a tank and valve located outside the tank at a point below lowest liquid level.*—Moore.
31943. ASSEMBLY OF RIVETS IN LINE WITH ONE ANOTHER FOR USE IN A METHOD OF RIVETING: *Rotating bowl and collecting rod.*—Aviation Developments Ltd.
31962. STRAINERS FOR TUBEWELLS: *Tubewell strainer having perforate tube enclosed by wire mesh and separating elements between a mesh and perforated jacket.*—Roy.
31963. STRAINERS FOR TUBEWELLS: *Tubewell strainer with threads on the outer surface engaging a wire wound round.*—Roy.
32043. ELECTRIC VACUUM TUBES AND THE LIKE: *Thermionic valve employing two co-axial metal tubes fixed and insulated at end inside the envelope, the outer tube being sealed through the envelope and the inner closed at its inside end.*—Standard Telephones and Cables Limited.
32304. PADLOCKS: *Housing and rotatable disc having slots, and lock for locking the disc.*—Young.
32328. PEGS FOR HANGING HATS, CLOTHES AND THE LIKE: *Screw or nail integral with peg.*—Ghosh.
32359. REFILL PAD FOR WRITING: *Made from plastic material and formed into one piece having a stream line holder on top and a stream line corner holder on the left.*—Quality Products Co. and Stoessel.
32373. GOLF-BAG: *Bundle of light tubes.*—Anderson.
32383. REFRACTORY RAMMING MATERIAL FROM HIGHLY SILICEOUS CHROME ORE: *Adding sodium silicate to the material obtained by the calcination of a mixture of magnesite and highly siliceous chrome ore.*—Mitra.
32402. COAXIAL TRANSMISSION LINES, PARTICULARLY IN THE TERMINATION THEREOF: *Resistive termination by a centrally apertured carbon disc, the peripheral surface and the internal surface of the aperture metallised.*—Marconi's Wireless Telegraph Company Limited.

32508. FILES: *Made of carbon steel containing less than 0.5 per cent. carbon carburised and hardened by induction.*—Robiette, and Mactaggart.
32555. TEES FOR GOLF BALLS: *Made of closely coiled wire.*—Hughes.
31125. A PRODUCT PREPARED BY HEATING VULCANIZED RUBBER SCRAP WITH A VEGETABLE OIL: *Treating vulcanised rubber scrap with a solvent.*—Jain Rubber Mills.
31245. ROPES, CORDS AND THE LIKE, PARTICULARLY OF WIRE: *Drawing plurality of wires from each of a plurality of cradles through guides and fair leads carried by a cylinder rotatable relatively to the cradles.*—British Ropes Ltd.
31358. COLOURING MATTERS FROM BHILAWAN NUT SHELL LIQUID: (SEME CARPUS ANACARDIUM): *By the reaction of bhilawan nut shell liquid with nitrous acid.*—Kudva and Kamath.
31412. JOINT FOR TUBES, RODS AND LIKE CYLINDRICAL MEMBERS: *Sleeve having internal annular groove and slot, tube having external annular groove and divided expansible ring in said grooves.*—Stewarts and Lloyds Limited.
31423. SOUND REPRODUCING DEVICES: *Fixing magnetic means in relation to diaphragm in a base by low melting metallic cement.*—Zenith Radio Corporation.
31466. ACROLEIN AND ETHYLENE: *Heating 2:3 dihydropyran at a temperature exceeding 350° C.*—I.C.I. Ltd.
31870. CAKE FORMER: *Grooved disc hinged to plain disc and locked.*—Chadray.
31872. WASHING MACHINE: *Tank, cylinder with perforated base, slotted disc, handle and steering wheel.*—Chadray.
32279. FLUSHING MEANS: *Operative upon the occupation of the seat or foot rest of a urinal.*—Khanna.
32394. PORTABLE PROJECTION SCREENS: *Screen collapsible in long box containing movably adjustable stabilising members.*—Stableford.
32483. PRINTING TEXTILE MATERIAL: *An operation of a water proof impervious endless blanket having indentations at its surface for securing powder in textile printing of great varieties of patterns and colours operated edges of dielectric sheets.*—Dewy and Almy Chemical Co.
32554. ELECTRICAL CONDENSERS: *Metal coating extending both sides round serrated edges of dielectric sheets.*—United Insulator Co., Ltd.
32584. PERAMBULATORS: *Sleeves under the carriage engage pins on under frame pelvic springs being interposed between; hook on two carriage spring engages hole in a central pin.*—Rege.
32608. COMPRESSION IGNITION ENGINES: *Air admitted with clockwise or anticlockwise motion, groove provided on top of piston to force swirling air into compression chamber.*—Robson, and Turner Mfg. Co., Ltd.
32613. GENERATORS OF SHORT DURATION ELECTRICAL PULSES: *Multivibrator circuit comprising two amplifiers and a cathode follower stage coupling output of one amplifier to control electrode of other and means to couple the output of latter to control electrode of the former.*—Standard Telephones and Cables Ltd.
31202. LUBRICATION SYSTEMS OF INTERNAL COMBUSTION ENGINES, COMPRESSORS AND THE LIKE: *Cyclic variation of pressure of lubricant synchronous with cyclic fluctuation of engine load.*—Aspin.
31209. RAILWAY SIGNALLING: *Two control solenoid having armatures controlling the negative terminals of the Up and Down signal circuits.*—Mukerjee.
31249. HEAVY DUTY PORTABLE CRANE: *Longitudinal body, upwardly inclined boom and swingable post.*—Letourneau, Inc.
31268. VARIABLE SPEED GEAR: *Whole of forward speeds operate on Synchro-mesh principle.*—Guy Motors Ltd., Andrews, Gilbert and Reece.
31336. REFINING AND CONCENTRATION OF MANGANESE, SILICA, GRAPHITE, CHROMITE AND LIKE ORES: *Agitating powered ore with emulsifying agent and then treating with a solvent.*—Chatterjee.
31337. MANGANESE DIOXIDE: *The product obtained after treating manganese ore with acid is heated. The manganese salt is isolated from the product and treated with a carbonate and the carbonate thus obtained is heated.*—Chatterjee.
31355. CLOCKS: *Revolving dials in place of hour, minute and second hands.*—Ali and Khan.
31504. FUSEL OIL DURING FERMENTATION: *Incorporating in the wort either the chloride or the phosphate of ammonia or amino acids.*—Iyengar.
31800. CHUCKS, SUITABLE FOR TAPS, REAMERS AND THE LIKE: *Body in two parts and grippers for shank and square of the tap.*—Fry and Bristol Agencies Ltd.
31835. SERVO-MOTORS: *Fluid pressure actuated driving means and control means for fluid pressure formed to respond to that pressure.*—Davy and United Eng. Co., Ltd.
32025. NEW RESINOUS CONDENSATION PRODUCTS: *Manufacture of resins by condensation reactions between etherified melamine formaldehyde condensation product and an etherified phenol formaldehyde condensation product.*—I.C.I. Ltd.
32044. AMINO ACID PREPARATIONS INTENDED FOR INTRAVENOUS SUPPLY OF NUTRIENTS: *Manufacture of amino acid nutrients by proteolysis followed by dialysis.*—Wretling.
32083. EMULSIFICATION OF PITCH: *Production of aqueous alkaline emulsion of coal tar pitch in presence of an emulsifier like natural asphalt.*—International Bitumen Emulsions Ltd.
32355. A PNEUMATIC PROCESS FOR AUTOMATIC AND EQUAL DISTRIBUTION OF COTTON OR WOOL FIBRES FOR SPINNING SEVERAL YARNS SIMULTANEOUSLY: *Supplying a mixture of air and loose fibres equally to wire gauze cones for drawing out the fibres for feeding several spindles for the production of several yarns simultaneously.*—Mukerjee.
32367. CART OR OTHER WHEELS: *Felloe having peripheral groove and tyre strung on flexible member the ends of which are passed through the felloe and secured.*—Gangulee.
32422. GUIDING AND STRETCHING DEVICE FOR FABRICS: *Comprising two guides, angle-shaped bracket, and tipping levers.*—Solankee.
32475. SPLICING WEBS: *Splicing tab having area of splicing adhesive.*—Wood Newspaper Machinery Corp.
32580. POWER TRANSMISSION MECHANISMS: *Epicyclic mechanism connected to the turbine, impeller, and the reaction member of hydro-kinetic mechanism through unidirectional clutches.*—Normanville.
30119. FUSELAGES FOR AIRCRAFT: *Cabin having skin plating formed with overlapping riveted joints and coated interally with elastic self-setting substance.*—Vickers-Armstrongs Ltd.
31052. PRE-STRESSED REINFORCED CONCRETE SKEEPPERS: *Open-ended trough mould with two paralleled end plates having open ended slots at each end.*—Bernier.

Journal of Scientific and Industrial Research

STUDIES ON INDUSTRIAL MICROORGANISMS

PART II—ALCOHOL TOLERANCE OF YEASTS

By S. R. ASWATHA NARAYANA RAO AND M. SREENIVASAYA

(From the Section of Fermentation Technology, Indian Institute of Science, Bangalore)

YEASTS show wide variations in their capacity to grow, to ferment sugars, to synthesize vitamins and to accomplish other biochemical reactions. By a careful selection of strains, it has been shown to be possible to secure cultures capable of giving the desired performance, e.g., yield of a certain percentage of alcohol. The importance of determining the alcohol tolerance of yeasts as a helpful and suggestive guide for making such selections has been emphasized by Gray¹. In connection with the problem of increasing the concentration of alcohol in distillery washes, the alcohol tolerance of a number of yeasts, from the National Collection of Type Cultures, India, has been investigated.

Experimental

Table I gives particulars of the organisms tried in these studies. Except for a few minor modifications, the method employed is essentially the same as the one outlined by Gray¹. The fermentation reactions were carried out in 50 ml. conical flasks. 10 ml.

of the medium consisting of 5 per cent. yeast water and 2 per cent. sucrose (recrystallized) was employed as the basal medium. Graded amounts of absolute alcohol, with increases of 0.5 ml., were added to the media and inoculated with 1 ml. of a suspension of yeast; the volume of the reaction mixture was finally made up to 25 ml. with sterile water. The inoculum was prepared by dispersing 12.5 gms. of wet yeast in sterile water and making up the volume to 100 ml. The flasks were then incubated at 30°C. for 24 hours; after this period, the residual sugar was estimated by the micromethod of Shaffer and Hartmann as described by Stiles, Peterson and Fred². The sugar consumed has been expressed as the percentage of the sugar initially present.

Discussion

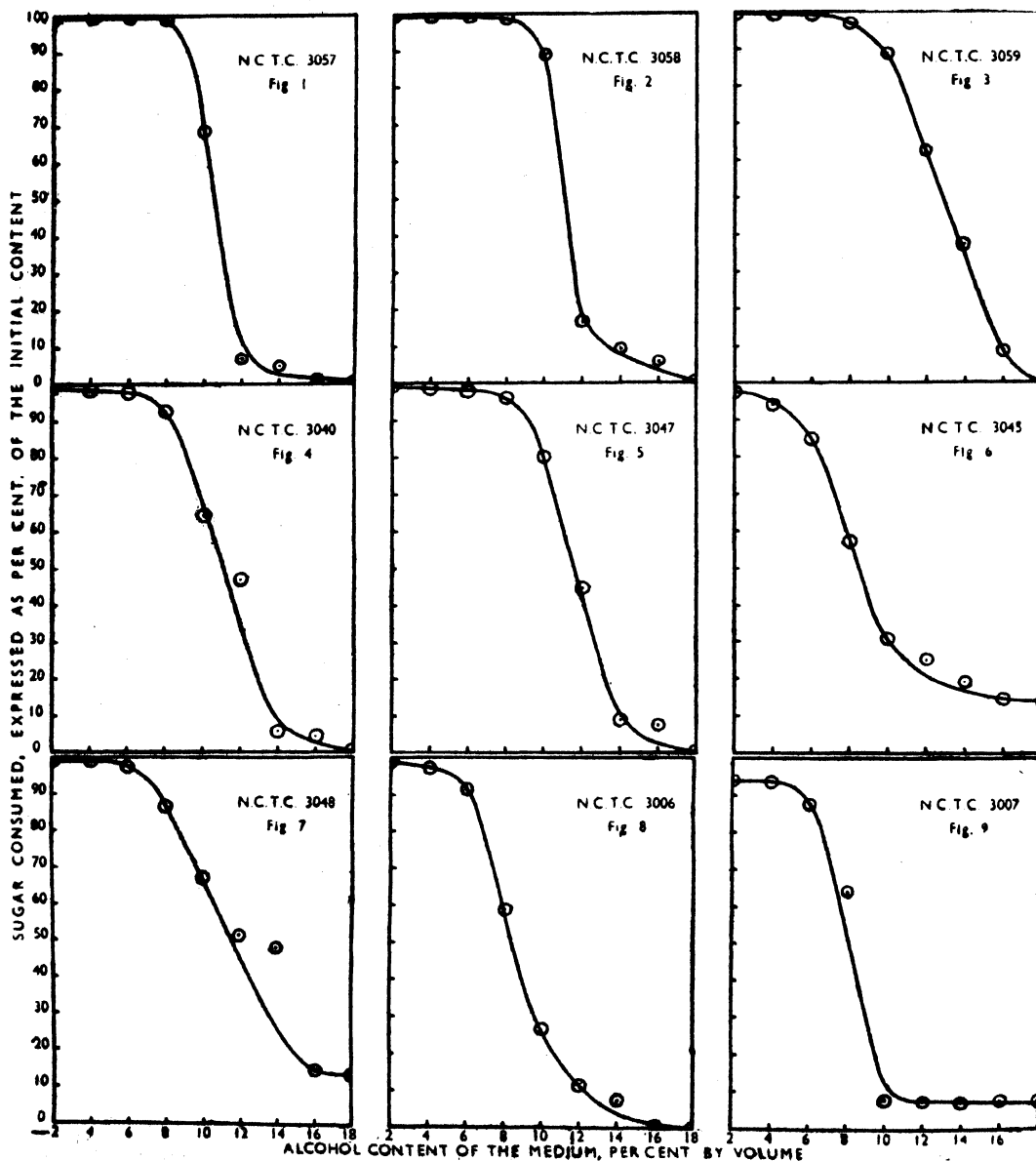
The results are given in Table II and have been graphically represented in Figs. 1-9. A careful study of the data and the curves reveal that the yeasts under study fall into three distinct groups as regards their alcohol

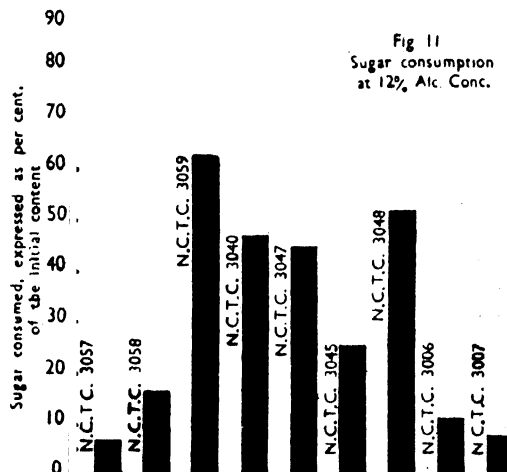
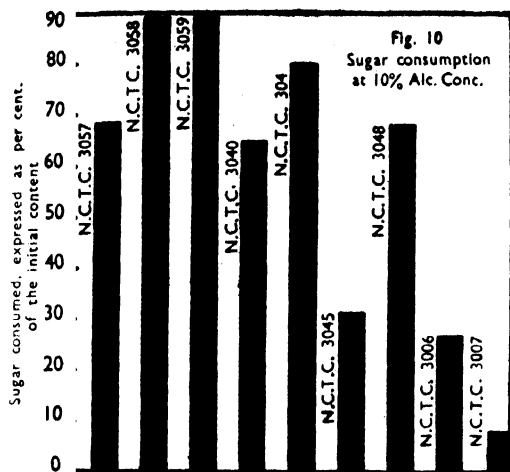
TABLE I.

No.	Type Culture No.	Strain of yeast	Source of organism	Remarks
1.	N.C.T.C. 3057	<i>Saccharomyces Cerevisiae</i>	Distillery sludge	
2.	N.C.T.C. 3058	"	"	
3.	N.C.T.C. 3059	"	"	
4.	N.C.T.C. 3040	"	"	
5.	N.C.T.C. 3045	<i>S. Ellipsoideus</i>	Steinberg strain	
6.	N.C.T.C. 3047	<i>S. Cerevisiae</i>	Hansen, from molasses	
7.	N.C.T.C. 3048	"	Hansen, Strain, Delft 1	
8.	N.C.T.C. 3006	"	Brewery sludge	Single cell isolation.
9.	N.C.T.C. 3007	"	"	"

TABLE II.

No.	Alcohol content per cent. by vol.	Percentages of sugar consumed.									
		N.C.T.C. 3057	N.C.T.C. 3058	N.C.T.C. 3059	N.C.T.C. 3040	N.C.T.C. 3045	N.C.T.C. 3047	N.C.T.C. 3048	N.C.T.C. 3006	N.C.T.C. 3007	
1.	2	99.4	99.2	99.5	99.2	97.7	99.3	99.2	98.9	94.4	
2.	4	99.4	99.1	99.4	98.7	94.2	98.7	99.2	97.6	93.7	
3.	6	99.4	99.0	99.4	98.1	85.0	98.0	97.9	92.0	88.0	
4.	8	99.4	98.7	96.9	93.0	57.4	96.2	86.9	59.0	64.3	
5.	10	68.5	89.1	88.9	64.5	31.1	80.0	67.9	26.8	8.2	
6.	12	6.8	16.7	62.8	47.2	25.5	45.0	52.2	11.7	7.9	
7.	14	6.5	9.6	37.5	5.9	19.6	9.1	48.5	7.7	7.6	
8.	16	1.4	6.3	8.9	4.7	14.9	7.8	15.0	0.5	7.9	
9.	18	0.4	0.4	0.0	0.5	14.3	0.4	14.0	0.2	8.2	





tolerance :—(1) those whose sugar consumption remains steady up to a concentration of six per cent. of alcohol and thereafter shows a rapid and sudden decline, giving a steep curve (see Figs. 4, 8 and 9); (2) those which maintain a high sugar consuming capacity in presence of 8 per cent. alcohol but which exhibit a rapid decline in that capacity at higher concentrations of alcohol and reach a point at which practically no sugar is consumed. In the case of this group the fall in the sugar consuming capacity in presence of increasing concentrations of alcohol, is gradual as shown by the graphs (see Figs. 1 2 and 5); (3) those whose sugar consuming capacity tends to remain appreciably high even at 10 per cent. concentration of alcohol. Among this group the fall in the capacity to consume sugar is still more gradual and the organisms retain this capacity to a significant measure (14 per cent.) even at 18 per cent. concentration of alcohol (see Fig 7).

For securing high percentages of alcohol in distillery washes, it is essential that the organisms should be able to function at high alcohol concentrations. The sugar consuming capacity of the strains of yeast in presence of 10 per cent. alcohol and in presence of 12 per cent. alcohol are illustrated in Figs. 10 and 11. The figures show in a striking manner that organisms which may be regarded as excellent for alcohol tolerance at 10 per cent. fail miserably at 12 per cent. alcohol concentration. Such histograms have not been

drawn for other concentrations of alcohol but a reference to the table and the figures will show that N.C.T.C. 3048 (see Fig. 7) appears to constitute one of the most promising strains; its ability to dissimilate significant amounts of sugar at an alcohol concentration of 18 per cent. is highly suggestive.

Summary

- (1) The alcohol tolerance of nine different yeasts from the National Collection of Type Cultures, has been studied; some of them have been isolated from the distillery and brewery sludges.
- (2) They group themselves into three distinct classes depending upon the degree of their alcohol tolerance; the data presented show that, N.C.T.C. 3059 and N.C.T.C. 3048 constitute the most promising strains for alcohol production.

Our grateful thanks are due to the Council of Scientific and Industrial Research for their generous support of a scheme of which the work described in this communication forms a part. Our sincere thanks are also due to Sir J. C. Ghosh for the keen interest he has taken in the progress of these studies.

References

- 1 Gray, W. D., *Bact. Jour.* 1941, 42, 561.
- 2 Stiles, H. R., Peterson, W. H., and Fred, E. B., *Ibid.*, 1926, 12, 427.

PECTIN FROM INDIAN PLANT MATERIALS

By M. DAMODARAN and P. N. RANGACHARI

(From the University Biochemical Laboratory, Madras)

PECTIC substances derive their technical importance from two facts. In the first place pectin has the characteristic property of forming sugar acid jellies and the ability of fruits to form jellies in the preparation of preserves and jams depends upon the pectin content of the fruit. Secondly, as substances in which galacturonic acid is quantitatively the preponderant structural constituent pectin is of great importance as the source of the galacturonic acid required for the large-scale synthesis of vitamin C. The present paper gives an account of a systematic investigation on the pectin content of some of the commoner Indian fruits and other plant materials and on the preparation of pectin from some of the richer sources.

Experimental

Estimation of Pectin Content.—The standard procedure for the determination of pectin is the method of Carré and Haynes¹ in which the plant material is extracted with acidulated water and the extracted pectin converted into pectic acid which is precipitated and weighed as calcium pectate; the results are expressed in terms of the calcium pectate number, i.e., the weight of calcium pectate obtained from hundred gms. of dry weight of plant material. The estimations were carried out as follows, the details of procedure described by Carré and Haynes¹ being followed without substantial modification.

15 to 20 gms. of the minced plant material were refluxed for three hours with 150 ml. of $\frac{N}{75}$ hydrochloric acid, the mixture cooled and filtered through a fluted filter paper. The residue was re-extracted as before with further lots of 150 ml. of hydrochloric acid and the combined filtrates made up to 500 ml. At the same time a 5 gm. sample of the minced material was dried at 105° C. for moisture determination.

100 ml. of the made-up solution were pipetted out into a 500 ml. beaker, neutralized to litmus with $\frac{N}{10}$ sodium hydroxide and a

further 100 ml. of $\frac{N}{10}$ sodium hydroxide

added to de-esterify the pectin. The solution after standing overnight was treated with 50 ml. of N acetic acid to render the medium acidic, and after five minutes with 50 ml. of a molar solution of calcium chloride when a gelatinous precipitate of calcium pectate was thrown down. The solution was allowed to stand for one hour, boiled for two to three minutes, filtered through a glass crucible (Jena G 4); the precipitate was washed repeatedly with hot water till the filtrate gave no test for chloride, dried to constant weight at 105°-110° C. The results of the estimation are given in Table I.

TABLE I.

Material	Moisture %	Cal. Pectate No.	
		Wet wt.	Dry wt.
<i>Citrus medica</i> (Lemon peel)	83.33	3.24	19.01
<i>Citrus pomelo</i> (Pomelo peel)	80.25	1.24	6.30
<i>Psidium guava</i> (Guava)	70.52	2.01	6.71
<i>Luffa acutangula</i> (Sweet gourd)	95.78	0.41	8.25
<i>Cucurbita pepo</i> (Pumpkin)	95.85	0.47	11.38
<i>Lagenaria vulgaris</i> (Gourd)	94.56	0.45	8.32
<i>Pyrus communis</i> (Country pears)	75.82	2.23	9.25
<i>Tamarindus Indica</i> (Fruit)	35.59	1.83	2.79
(Seed)	12.89	0.00	0.00
<i>Colocassia antiquorum</i> (Tuber)	36.52	2.06	3.52
<i>Ipomaea batatas</i> (Sweet potato)	34.82	1.99	3.12
<i>Feronia elephantia</i> (Wood apple)	38.17	1.89	3.07
<i>Artocarpus integrifolia</i> (Jack fruit seed)	26.72	2.50	3.51
(Jack fruit)	75.79	2.20	9.15
<i>Cucumis melo</i> (Melon)	94.11	0.613	12.25
<i>Ananas comosus</i> (Pine-apple)	93.36	0.093	1.32
<i>Borassus flabellifer</i> (Palmyra fruit, nongu)	95.85	0.00	0.00
<i>Carica papaya</i> (Papaya fruit)	89.49	0.645	5.85
<i>Mangifera Indica</i> (Mango, Bangalore)	83.40	0.494	2.91
" (Rumani)	87.64	0.444	3.70
<i>Musa paradisiaca</i> (Plantain)	72.06	0.954	3.41
<i>Kigella pinnata</i> DC	81.84	1.072	5.95

From the calcium pectate numbers given in Table I, it will be seen that in addition to *citrus peel*, *guava*, *pumpkin*, *country pears*, *pomelo peel* and *melon* are good sources of pectin. It is a striking fact that *tamarind seed* which has been claimed to be a rich source of pectin (Krishna and Ghose)² gave no calcium pectate. On account of this anomalous result, the substance from tamarind seed considered to be a pectin by the above authors was prepared according to the method described by them and examined in some detail when it was found that it did not have the chemical properties and structure characteristic of pectin (Damodaran and Rangachari)³.

Preparation of Pectin

From the richer sources as judged from the calcium pectate number, pectin preparations were made by the following procedure. About 500 gms. of the material were brought into a fine state of division by grinding or mincing. Fruits like *guava* and *country pears* which gave strongly pigmented products when put through metal mincers were ground in a granite end-runner mill.

The thoroughly minced or ground material was extracted two or three times by boiling for one to one and a half hours with 75 per cent. hydrochloric acid. The extracts were filtered under suction and concentrated under reduced pressure at a temperature of 40°-45° C. The extraneous material which separated out during concentration was removed by centrifuging and the solution finally concentrated to a syrup. This was poured in a thin stream with vigorous stirring into sufficient 95 per cent. alcohol to give a final alcohol concentration of 70 per cent. The pectin which was precipitated as a flocculent jelly was filtered and dehydrated by washing further with higher strength alcohol and finally with acetone. It was then dried in a vacuum desiccator at room temperature. White powders were thus obtained with *pumpkin* and *citrus* and *pomelo peel*; the preparations from *guava* and *country pears* had a pale brownish tint.

All the preparations formed good stiff jellies under the usual conditions, i.e., a solution containing 65 per cent. cane sugar, 1.5 per cent. pectin and 1 per cent. citric acid. 0.5 gm. of the pectin was mixed with 3 gms. of cane sugar and this was dissolved in 30 ml. of water. After all the pectin had

gone into solution, the remaining 19 gms. of sugar were added and then 0.3 gm. of citric acid and the whole solution boiled for a few minutes and allowed to cool.

Preparations were also made from some of the poorer sources such as sweet potato, colocassia tuber, tamarind fruit, jack fruit seed; these, however, did not form jellies under the conditions stated above.

Analysis of the Crude Preparations.—All the pectin preparations obtained as above were submitted to analysis for the determination of uronic acid and methoxyl content.

Uronic Acid Determination.—The method of Dickson, Otterson and Link⁴ was followed using the apparatus described by them. 0.1 to 0.5 gm. of the material was heated with 100 ml. of 12 per cent. hydrochloric acid to 135°-140° C., the carbon dioxide formed by decarboxylation swept out of the apparatus by a current of carbon dioxide free air and absorbed in a tower containing standard barium hydroxide solution. The experiment was run for 4½ hours and at the end of the period, the excess baryta titrated against standard hydrochloric acid using phenolphthalein as indicator. The percentage of carbon dioxide was calculated from the results of the experiment and four times the percentage of carbon dioxide gave the percentage of uronic anhydride.

Methoxyl.—The methoxyl values were determined by the usual micro-Zeisel method (Pregl). The analytical values are given in Table II.

TABLE II.

Material	Crude pectin	
	OMe %	Uronic acid %
<i>Citrus medica</i> (Lemon peel)	5.97	75.48
<i>Citrus pomelo</i> (Pomelo peel)	5.25	54.66
<i>Psidium guava</i> (Guava)	6.25	50.44
<i>Luffa acutangula</i> (Sweet gourd)		47.64
<i>Cucurbita pepo</i> (Pumpkin)	5.02	51.34
<i>Pyrus communis</i> (Country pears)	6.12	54.72
<i>Tamarindus indica</i> (Fruit)	2.16	14.32
<i>Tamarindus indica</i> (Seed)	1.08	12.60
<i>Colocassia antiquorum</i> (Tuber)	1.59	18.57
<i>Ipomoea batatas</i> (Sweet potato)	2.19	14.08
<i>Artocarpus integrifolia</i> (Jack fruit seed)	2.13	14.31

As the tabulated results indicate, none of the preparations represent pure pectin, even those which give satisfactory jellies having a uronic acid and methoxyl content much lower than that given in the literature for highly purified pectin preparations. Pectin is now known to be a macro-molecule

consisting essentially of a chain of partially methylated galacturonic acid residues. The arabinose and galactose which were formerly considered to be essential units of the pectin molecule are considered by certain workers to be impurities. Thus Schneider *et al.*⁵ claim to have obtained pectin preparations consisting almost entirely of uronic acid units, the uronic acid value being 96 per cent. and methoxyl value 11.6 per cent. Good quality commercial preparations usually contain about 68 per cent. of uronic acid and 6 per cent. of methoxyl respectively. The methoxyl and uronic acid contents of some of the preparations (*tamarind seed*, *tamarind fruit*, *colocassia tuber*, *sweet potato* and *jack fruit seed*) were so low that it was considered not worth while to investigate them further as possible sources of pectin.

But the fruits—*guava*, *pumpkin*, *country pears*, *pomelo*—which had high methoxyl and uronic acid values and which gave good jellies were submitted to further purification.

Purification

Two methods of purification were found useful in giving preparations with higher methoxyl and uronic acid values, viz., treatment with bromine water (Nanji and Chinoy)⁶ and repeated precipitation with decreasing strengths of alcohol. For purification with bromine water, the pectin was dissolved in hot water and the solution was treated with 20 ml. of N/10 bromine water for each gm. of pectin. The solution after keeping at 37° C. for 24 hours and at 40° C. for a further 1 to 2 hours, was filtered, and the excess of bromine removed by shaking up with ether. The aqueous solution was concentrated under reduced pressure and precipitated by addition of alcohol to 70 per cent. final concentration. The pectins so obtained on filtration and drying *in vacuo* were quite colourless products. The purified products gave good jellies with sugar showing that no degradative change had taken place.

In the second method of purification, the pectin samples were dissolved in hot water and filtered from suspended impurities through kieselguhr. The clear solution obtained was concentrated under reduced pressure and precipitated with alcohol added to a final concentration of 70 per cent. The

procedure was repeated, the alcohol concentration at which precipitation was carried out being reduced to 60 per cent. in the second precipitation and to 50 per cent. in the third precipitation.

Results of the analysis after these treatments are given in Tables III and IV.

TABLE III. Treatment with Bromine Water.

Material	Pumpkin	Guava	Pomelo	Country Pears
Before purification	51.34	50.44	54.68	54.72
Percentage of Uronic acid				
After purification	67.38	65.92	71.84	75.56

TABLE IV. Repeated Precipitation with Different Alcohol Strengths.

Material		70%	60%	50%
Pumpkin	Uronic acid %	49.28	55.72	82.16
	Methoxyl %	5.023	5.344	9.74
Guava	Uronic acid %	76.52	80.54	85.12
	Methoxyl %	7.84	8.074	8.10
Pomelo	Uronic acid %	55.92	75.16	86.23
	Methoxyl %	5.241	6.873	8.29

Summary

The pectin content of a number of Indian fruits and other plant materials has been determined.

It is shown that in addition to *citrus peel*, *guava*, *country pears*, *pumpkin* and *pomelo peel* are rich sources of pectin from which pectin of commercial quality can be readily prepared and that contrary to previous claims, *tamarind seed* contains no pectin.

Methods of purification which may be used for obtaining preparations suitable for chemical investigation are indicated.

References

- Norman, A. G., *Biochemistry of Cellulose, Polyuronides, Lignins, etc.*, Oxford, 1937, p. 75.
- Doree, *Methods of Cellulose Chemistry*, London, 1933, pp. 354.
- Pregl, *Quantitative Micro Analysis*, London, 1937.
- Carrè & Haynes, *Biochem. J.*, 1922, 16, 60.
- Krishna & Ghose, *J. Ind. Chem. Soc.; Ind. & News Edn.*, 1942, 5, 114.
- Damodaran & Rangachari, *Curr. Sci.*, 1945, 14, 203.
- Dickson, Otterson & Link, *J. Amer. Chem. Soc.*, 1930, 52, 775.
- Schneider *et al.*, *Ber.*, 1936, 69, 309, 2530, 2537; 1937, 70, 1611, 1617; 1938, 71, 1353.
- Nanji & Chinoy, *Biochem. J.*, 1934, 28, 456.

A MOBILE PRODUCER-GAS PLANT USING INFERIOR GRADES OF CHARCOAL AND WOOD-CHIPS AS FUEL

PART I

By B. SENGUPTA AND V. V. APTE

(Department of Industries, Bombay)

ACCORDING to the computation made by the War Transport Department of the Government of India, the number of vehicles using producer gas as fuel in India, was 16,000 in October 1944¹. This number can reasonably be expected to have risen to 22,000 vehicles upto the month of August 1945. A large-scale conversion of vehicles to producer gas has created an abnormal demand on superior quality charcoal, specially manufactured, to suit the requirements of producer-gas plants. It is estimated that a transport vehicle covering a distance of 1,500 miles per month consumes about one ton of charcoal during that time including wastage, etc. On this basis, arrangements have to be made to manufacture at least 22,000 tons of superior grade charcoal per month in order to keep all these vehicles on the road. Besides the manufacture of this enormous quantity of charcoal, the problem of its distribution to centres of consumption and the need for control over its quality and price, make the setting up of a vast organization imperative. In Australia, such activities appear to have been accepted as a State responsibility, a Federal Officer acting as a co-ordinator between the manufacturer and the consumer².

The position of supply of producer-gas charcoal in various Provinces in India is not very satisfactory. Besides the inadequate supply of charcoal, the quality of charcoal available in a number of places is so inferior as to make its use extremely difficult as a producer-gas plant fuel. The charcoal available in Bombay, generally contains a high percentage of moisture and volatiles, making it unsuitable for use in updraught and cross-draught generators. This has resulted in a widespread aversion towards the fitting of producer-gas plants to motor vehicles.

The problem of charcoal supplies for producer-gas

plants appears to be a difficult one and charcoal supply is acting as the main obstacle in the way of popularizing producer-gas driven vehicles. The object of this paper is to make an approach to this problem from quite a different direction. Instead of trying to improve the quality of charcoal for obtaining better performance of the producer-gas plants, it is possible to design a producer-gas plant which can use low grade fuel available at present without its accompanying disadvantages. Successful attempts have been made in Continental Europe in this direction, but no such attempt appears to have been made in India.

Characteristics of Producer-gas Plants

A study of the characteristics of different types of plants will enable one to judge the relative merits and drawbacks of these plants and will suggest the direction in which an improvement is necessary. Fig. 1 shows the three conventional types of producer-gas generator, viz., the updraught, the crossdraught and the downdraught generators.

The updraught generators are usually quick to start on gas from the time of lighting, quick to take load once the engine starts running on gas, and produce gas which develops about 10 to 15 per cent. higher

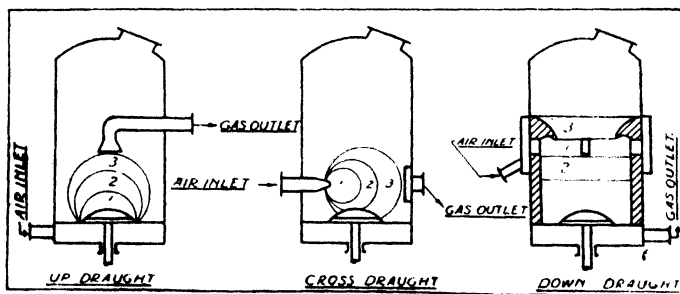


Fig. 1. Different types of P. G. Generators.

1. Combustion Zone.
2. Reduction Zone.
3. Distillation Zone.

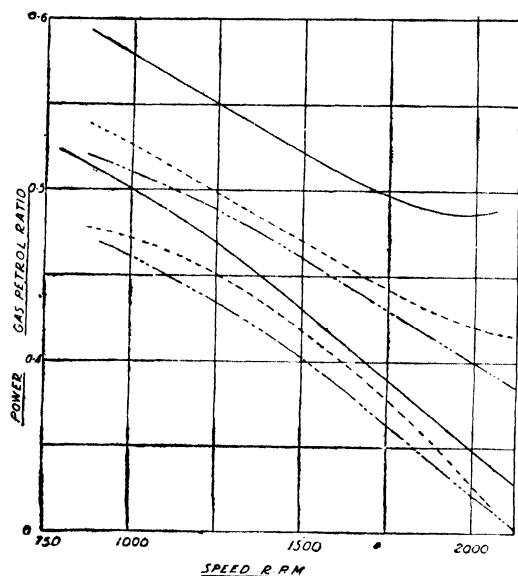


Fig. 2. Upper and lower limits of power-ratio at different speeds for different types of generators.

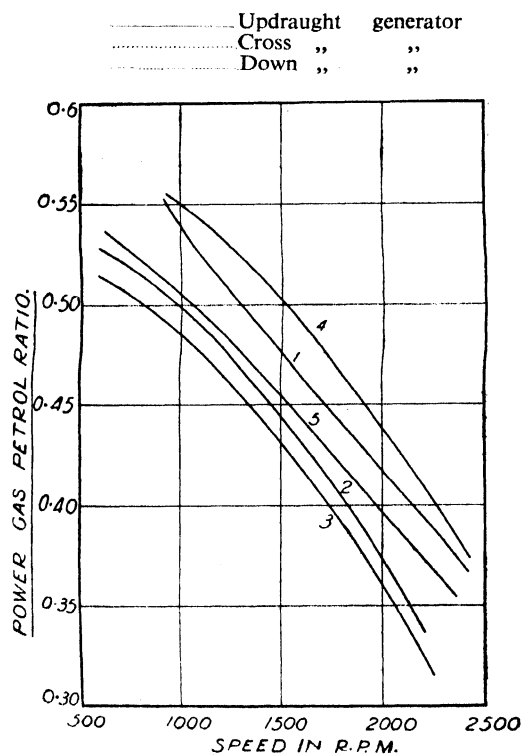


Fig. 3. Mean power ratio at different speeds for different types of generators or downdraught generator using wood or charcoal. 1. Updraught. 2. Cross-draught. 3. Downdraught. 4. Wood. 5. Charcoal.

power as compared to the other types of generators (*vide* Figs. 2 and 3).

This performance is, however, subject to the use of superior quality of charcoal. As the position of the distillation zone in the updraught plant is near the gas outlet (*vide* Fig. 1), the moisture and the volatiles in the charcoal are carried along with the gas. If the charcoal contains a high percentage of moisture and volatiles, the obvious result is the clogging of the filters and the consequent drop in the power developed by the engine. The updraught generator appears to be universally adopted in Australia with great success, as arrangements for adequate supply of specially made charcoal are in existence there.

The characteristics of the crossdraught generators are similar to those of the updraught generators so far as the starting time and the loading time are concerned. These plants, however, are, not capable of developing as high a power as the updraught generators although the power developed is about 5 per cent. higher than that developed with a downdraught generator (*vide* Figs. 2 and 3). Inferior grades of fuels containing high percentage of moisture and volatiles provide the same handicaps as in the case of an up-draught generator.

The relative positions of the distillation and the reduction zones in the downdraught type of generator (*vide* Fig. 1) makes it eminently suitable for fuels with high moisture and volatile contents. The steam and the volatiles liberated from charcoal have to pass through the high-temperature combustion and reduction zones where the steam is decomposed into the component elements and the tar-producing volatiles are completely burnt. This type of generator, therefore, suggests itself for adoption when the quality of charcoal is inferior. A number of tests taken on various downdraught type of producer-gas plant models, however, shows that this type suffers from many disadvantages, prominent among them being (i) high starting time, (ii) long interval of time before the engine can take full load once it starts on gas, (iii) low power developed as compared with an updraught plant, (iv) comparatively low calorific value of the gas and, lastly, (v) inability to completely eliminate the moisture and volatiles in the fuel.

The statement above will be clear from Table I, giving the results of bench-tests in

TABLE I. *Relative Performance of the Three Types of P. G. Plants.*

Type of plant	Number of tests	Number of models tested	Average starting time		Average loading time	Mean power ratio (Gas/Petrol ratio)
			min.	sec.		
Updraught	31	18	2	— 42	Less than 5 mins.	0.48
Crossdraught	19	7	2	— 32	Less than 5 mins.	0.45
Downdraught	12	8	5	— 3	Between 15 and 30 mins.	0.43

the Producer-Gas Plant Testing Laboratory, Bombay.

Study of Downdraught Plant Designs

The comparatively unsatisfactory performance of the downdraught plants calls for careful examination of its design. The direction of flow of the gas and the high temperature at the outlet can account for some of the power-loss, but the reduction of power on this account is comparatively small. The major loss of power is probably due to the setting up of irregular reaction zones in the generator.

Fig. 4 shows the sectional elevation and the cross-section of a typical downdraught generator. The suction air is admitted to the air-belt through a pipe of about 2" in diameter (3.14 sq. in. area) and is led into the generator through four rectangular air-ports, approximately 1" × 1.5", that is, having an aggregate area of 1.5 sq. in. The annular space between the cylindrical refractory lining and the generator shell, which is usually about 0.25" wide and 18" deep, is filled with fire-clay poured in liquid form and allowed to settle. Figure 5 shows a diagrammatic sketch of the hearth part of this type of generator.

During the bench-test of this type of generator, the following observations were made:—

- (a) The portion of the air-belt shell facing the air ports A and B (Fig. 5) developed hot patches, whereas the portion facing air ports C and D remained comparatively cool,
- (b) The generator shell below the grate became very hot, showing sometimes a red glow,
- (c) When the torch-hole P was kept open and the air inlet closed, the engine came on gas within 5 minutes of lighting the generator, petrol being used for starting. But, as soon as the normal air port was opened and the torch-hole closed, the engine failed to run on gas alone and required to be boosted up with petrol for a long

time before the petrol could be completely cut off and

- (d) Even after the engine came on gas, it took about 15 minutes before the plant could generate gas enough for loading the engine to its full capacity.

These observations naturally lead to the conclusions that :—

- (i) Most of the air enters the generator through the air-ports A and B which are nearer the inlet pipe so that the ports C and D do not function properly and as a result, there is a partial absence of the reduction zones at the ports C and D,
- (ii) The fire-clay which is poured in the annular space between the fire-brick lining and the generator shell, develops cracks on drying and results in air-leaks past the refractory lining. The hot producer-gas coming in contact with the air burns below the grate, thus developing hot patches on the generator-shell below the grate,
- (iii) During the lighting up operation through the torch-hole, only the portion X (Fig. 5) is ignited. As soon as the normal air ports are in operation and the torch-hole closed, the air admitted through all the four ports does not enter into chemical reaction, thus resulting in the failure of the engine to run on gas unaided by petrol for a considerable length of time, and
- (iv) The relatively small area of the air inlet pipe as compared to the aggregate area of the air-ports causes unequal distribution of air through all the ports. This defect, coupled with the fact that the charcoal is ignited only on one side of the generator during the lighting up operation, explains the reason for the long interval of time before the proper combustion and reduction zones are set up over the entire cross-section of the generator.

Improvements Suggested

In view of the above observations, some manufacturers of downdraught producer-gas

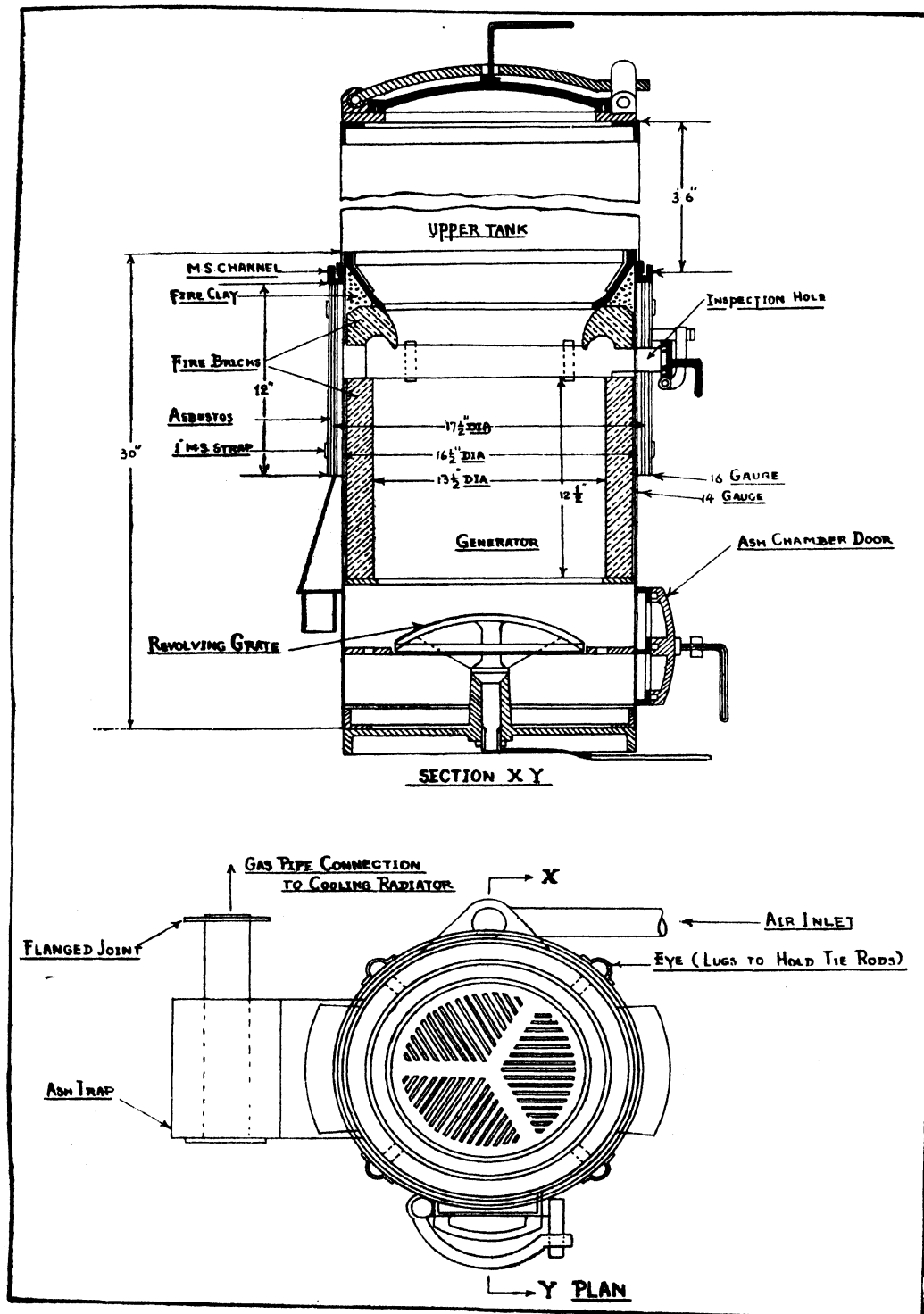


Fig. 4—Typical Downdraught Producer-Gas Plant

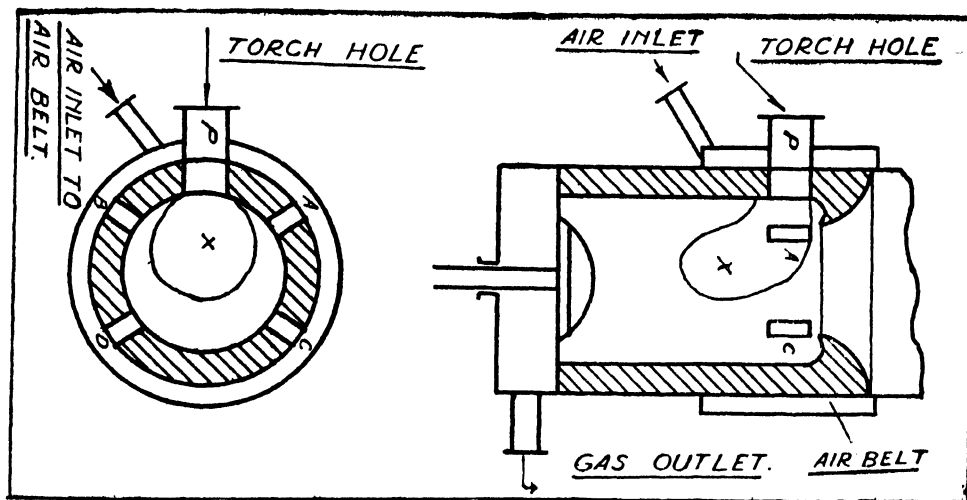


Fig. 5

plants, who had submitted their model plants for test, were advised to incorporate the following modifications in their designs:—

- (1) Provision of a second air inlet pipe to the air-belt just opposite the existing air-inlet with a view to improving the distribution of air between the air-ports A, B and C, D (Fig. 6). A model of downdraught generator modified as above, showed a marked improvement in power.
- (2) Reduction of the area of the air ports A and B by about 50 per cent. keeping the area of the air ports C and D unaltered. The modification in another model of downdraught plant designed to cause a better distribution of air, resulted in appreciable increase in power.
- (3) **Some New Features**
- Although, the above modifications improved power to some extent, all the other defects detailed in a previous paragraph, still remained. It was, therefore, decided to incorporate the following new features in the downdraught plant in an attempt to eliminate the defects and to evolve a new type of generator working on the downdraught principle:
- (1) Equal distribution of air to the air-ports by providing independent air-inlet pipe connections to each air-port,
- (2) Increased velocity of air through the air-ports by reducing their area,
- (3) More uniform distribution of air at the combustion zone of the generator by
- providing a greater number of air openings,
- (4) Shaping the refractory lining so as to reduce the cross-section of the hearth at the reduction zone to about 25 per cent. of the area at the air-inlet thus ensuring a quick establishment of reduction zone and almost complete elimination of moisture and tar producing volatiles from the gas,
- (5) Lighting of the generator in the centre instead of lighting on one side which, naturally, helps to spread the fire quickly over the entire cross-section and to reduce the time required for loading the generator,
- (6) Provision of a removable hearth for facilitating its inspection, repairs or replacement, and

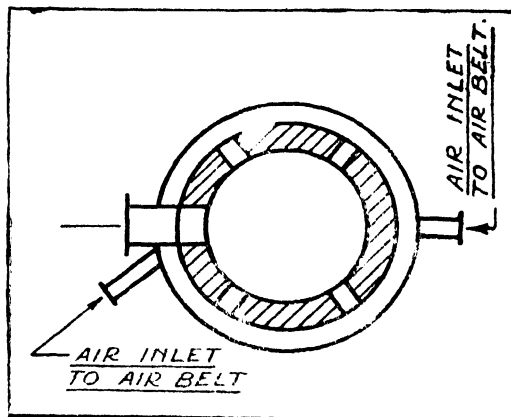


Fig. 6

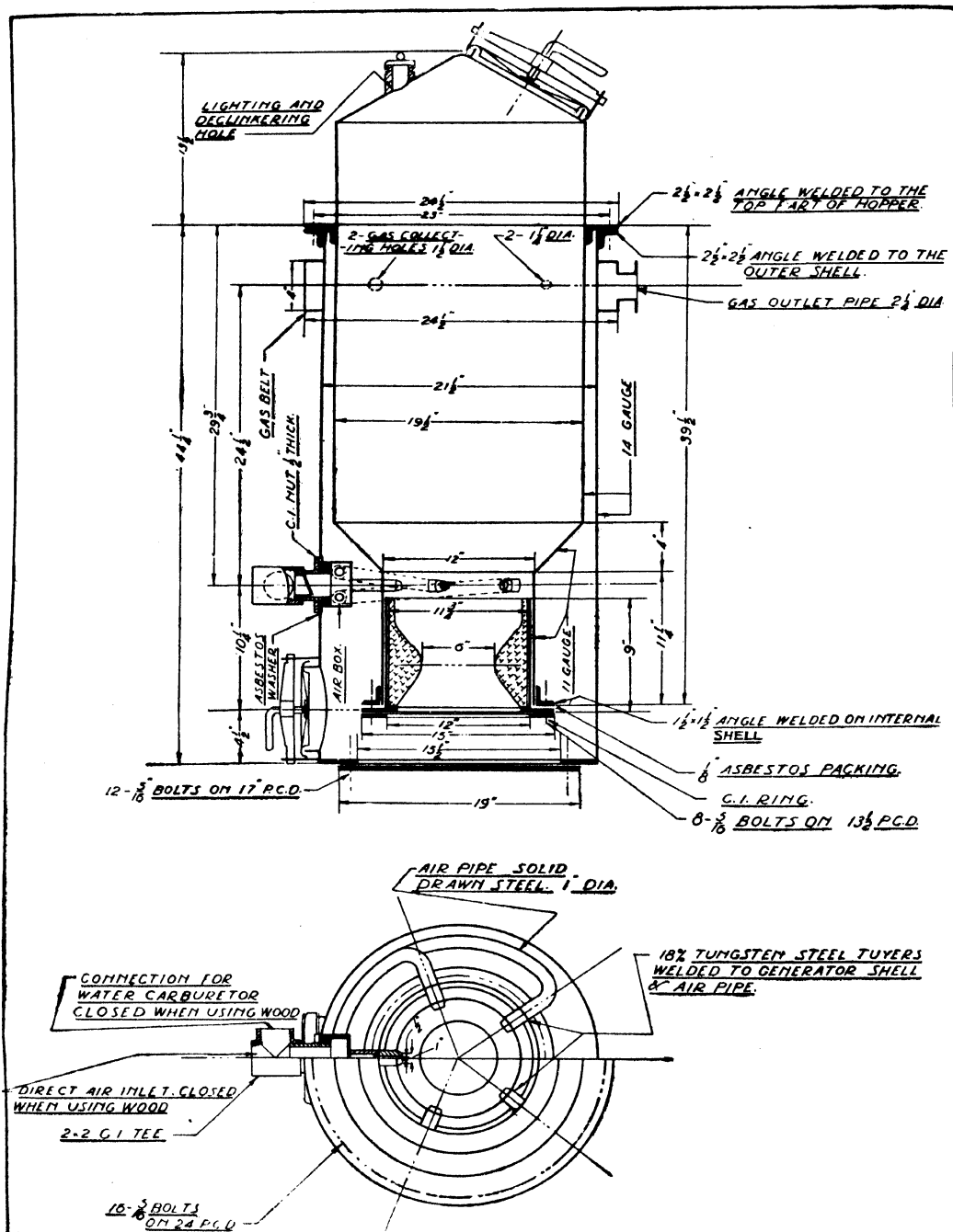


Fig.

- (7) Construction of the refractory lining of the hearth from segmental fire bricks instead of the usual precast cylindrical refractory pipe. This helps the building up of the hearth with the aid of fire cement and reduces the possibility of air-leaks past the refractory lining.

The New Generator

Fig. 7 shows the sectional elevation and the plan of the modified form of the down-draught generator, and fitted to a vehicle used in the Producer-Gas Plant Testing Laboratory of the Department of Industries, Bombay.

The generator is of the conventional down-draught type and of double-shell construction. Air is admitted through the galvanized iron pipe A, 2" in diameter, which leads the air to the air-distributor box B between the inner and the outer shells of the generator. Five independent solid-drawn mild steel pipes of 1" diameter each, lead the air from the distributor box to five tuyeres or nozzles spaced round the generator at angles of 75° from each other. The tuyeres have an internal diameter of 0.5" and are made of 18 per cent. tungsten steel. The use of this steel prevents the burning of the tuyeres.

The furnace or hearth of the generator is made removable through the bottom-opening of the generator. It is lined with 12 highly aluminous segmental fire-bricks which are fixed in their places in the cylindrical mild steel hearth-shell by fire-cement. The hearth is 10" in internal diameter and 11" in depth with a waist 6" in diameter at the centre. The hearth is bolted to the inner shell of the generator by means of 12 bolts.

The generator is lighted by inserting a piece of lighted charcoal at the centre of the hearth just below the air-inlet through a removable pipe inserted through the opening

C in the hopper. After a draw for about a minute, the pipe is removed and the opening C closed by a screwed cap. A high temperature zone is quickly set up near the narrow waist of the hearth through which all the products of distillation pass. The gas is then deflected upwards through the annular space between the inner and the outer shells. A part of the heat from the gas is dissipated through the outer shell to the atmosphere. Whereas the remaining part of the heat is conducted through the inner shell to the fuel in the hopper and serves to separate moisture and volatiles from the fuel. The gas is led to the collecting ring through four holes in the outer shell at its upper end and thence led to the coolers by a pipe of suitable diameter.

As the aggregate area of the nozzles is much less than the area of the air-inlet pipe, an even distribution of air through all the nozzles is assured. The velocity of air through each nozzle is increased to about five times the usual velocity of air through the ports in a conventional downdraught plant.

Bench Tests

This plant was tested at the Testing Laboratory repeatedly using various types of charcoal as fuel. The result of a series of tests using charcoal as fuel are tabulated in Table II.

The charcoal used for the above tests was purchased from the local charcoal depots. It was of inferior quality and contained high percentages of moisture and volatiles. In two of the above tests, charcoal was further moistened in the Laboratory by adding about two gallons of water to every 150 lbs. of charcoal.

A reference to Fig. 3, which shows the mean power curves of the conventional up-cross and downdraught as well as the modified downdraught generators, and to

TABLE II. Bench Test Results on Modified Downdraught Generator.

No.	Starting time min. sec.	Loading Time	Maximum total pressure drop across the plant in inches Hg.	Maximum temp. rise °F.	Cal. value of Gas B.T.U./c.ft.	Power ratio (Gas/Petrol)	Remarks
1	2 — 30	Less than 5 mins.	1.5	26		0.48	Charcoal moistened
2	4 — 00	10 mins.	2.0	30		0.453	
3	5 — 00	Less than 5 mins.	2.5	26	101.7	0.427	
4	2 — 15	Do.	2.8	16	115.8	0.438	Top half of generator charged with wood chips.
5	1 — 30	Do.	2.6	40	108.5	0.468	
6	5 — 00	Do.	2.6			0.442	
7	8 — 30	Do.	3.0	28	131	0.455	
Average						0.452	

Table II, will make it clear that the modified generator has most of the advantages of the updraught and the downdraught generators. The plant presents only one difficulty, viz., that it requires still a comparatively high starting time. The work in connection with the improvement in this direction is in progress.

The examination of filters and the test filter-paper after the bench-tests with this plant showed that almost all the moisture and volatiles from the charcoal were eliminated.

Wood-chips as Fuel

The results obtained by using inferior grades of charcoal in this generator encouraged the authors to try it out for the generation of wood gas. Waste wood (teak and jungle wood) from the motor body building factories in Bombay was obtained. The size of chips used varied from $\frac{1}{2}$ " square and 2" long to about 1" square and 4" long. The part of the generator upto the tuyere-mouth was charged with charcoal and the remaining part was filled with wood chips. The results of the bench-tests with wood chips as fuel are tabulated in Table III.

A comparison between Tables I and II, and Table III will show that the wood fuel produces about 10 per cent. higher power than that produced with charcoal fuel and 15.3 per cent. higher power than that obtained with the conventional downdraught plant using charcoal as fuel. Further, the power developed is even greater than the power developed by a conventional updraught plant. These are clearly indicated in Fig. 3 which shows the comparative power curves for different types of generators. It was noticed during the tests that, for the first half an hour or so, the power developed was comparatively low. This is due to the fact that for the first half an hour, the gas is

generated from the charcoal placed at the bottom of the generator as the bed-charge. As the bed-charge is consumed, the power gradually rises to a steady maximum indicating that the complete change of fuel has taken place. The initial charge of charcoal at the bottom of the generator is necessary in order to facilitate the lighting of the generator and to provide an initial bed of carbon for the secondary or the reduction zone.

Examination of the filters and the test filter paper after the bench-test showed that almost all the moisture and tar contained in the wood were eliminated, although not to the same extent as in the case of charcoal. This indicates that, probably, for wood gas generation, the waist of the hearth will have to be further reduced in diameter. Experiments in this direction are still in progress.

Road Trials

The results obtained in the laboratory with this plant were subsequently confirmed by road tests. The plant was fitted on to a 1943 model Chevrolet lease-lend truck, with a standard 30 h.p. engine. For the purposes of these tests, the truck was loaded with a load of about one ton. The load was purposely kept lower than the usual standard test-load in order to have at disposal during the tests enough spare engine power especially when the hill-climb tests were taken on the steepest gradients on the Bombay-Poona road. The main object of the road trials was to find out the power improvement and the reliability of the plant with wood-fuel as compared to charcoal fuel under the same load conditions. The tests were taken on road between Bombay and Poona (concrete-surface) and the hill-climb tests were taken on the Bhore Ghat on the Bombay-Poona road. The average gradient

TABLE III. Bench Test Results with Wood Chips as Fuel.

No.	Starting time Min. Sec.	Loading time	Maximum total pressure- drop across the plant in inches of Hg.	Maximum temp. rise °F.	Cal. value of Gas B.T.U./c.ft.	Mean power ratio (Gas, Petrol)	Remarks.
1	4 — 20	Less than 5 mins.		42		0.509	
2	3 — 10	Do.	2.2	20		0.463	
3	3 — 0	Do.	2.0	54		0.498	
4			2.8	36		0.520	
5			3.4	42	154.6	0.45	
6	6 — 00	Less than 5 mins.	2.4	26		0.50	Filter choked up. Test given up.
7	9 — 00	Do.	2.0	40		0.523	
8	6 — 00	Do.	2.8	50	171.0	0.504	
Average						0.503	

of the Bhor Ghat is approximately 1 in 10. The results of the road tests are tabulated in Table IV.

TABLE IV. *Summary of Road Tests.*

Fuel used	Total mileage	Mean starting time Min. Sec.	Mean hill-climb ratio	Maximum speed on level road Miles/hr.	Fuel consumption lbs./mile.
Charcoal ..	476	4—5	0.44	50	1.48
Wood ..	808	7—4	0.52	50	1.62

Note.—Although the maximum speed recorded on charcoal is shown in the above table as 50 miles per hour, it was only on one occasion, that this speed was attained with charcoal as fuel. Barring that one occasion, the maximum speed on charcoal varied between 40 and 45 miles per hour, whereas, with wood fuel, it varied between 45 and 50 miles per hour.

During the road trials, one interesting feature of this plant was noticed. The generator could be run without charge, till the fuel-bed dropped to the level of the waist of the hearth without overheating the generator. This is a great advantage over the other types of generators, which have to be refuelled before the fuel level in the generator drops below half the height of the generator.

The results of the road tests and bench-tests show fairly conclusively, that the power and the maximum speed of the vehicle obtained with wood fuel are much higher than that obtained with charcoal. The amount of air required for carburation is considerably greater in the case of wood gas. This observation can also be corroborated from the figures of calorific value and gas analysis. With the increased quantity of air required for the carburation of wood gas, there is a corresponding reduction in the suction of gas through the producer-gas plant at different engine speeds. This in return reduces the pressure-drop across the filters and as a result, increases the distance that can be covered by the vehicle before the filters require cleaning. Further, the reduction in the pressure-drop across the plant, naturally, contributes towards the increase of power in the case of wood gas generator. This factor also contributes to the higher efficiency of the coolers and filters and increases, to some extent, the operational life of the plant. The improvement of the overall performance of the engine due to the use of wood gas may be clearly seen from Tables I and II and Fig. 3.

Conclusions

The results show that wood can be successfully used as fuel for mobile producer-gas plants in India. The power obtained from wood fuel is appreciably greater than that obtained with charcoal fuel. Wood gas generator is cleaner to operate and eliminates many disadvantages from which the existing designs of producer-gas plants operated on charcoal suffer. Wood is extensively used as a fuel for motor vehicles in continental Europe, because it affords a cheaper fuel². Even from the point of view of national economy in raw materials, wood gas generators have a great advantage, since for every unit of wood used directly in the generator, two to three times as much wood must be carbonized to produce the equivalent amount of charcoal. Ribers³ reports that in Sweden, the prices, reliability and the distances covered per generator-charge in the case of both the charcoal gas and the wood gas generators are about the same. If any attempt is to be made to evolve a standard producer-gas plant for universal adoption in India, the plant must be capable of giving satisfactory service and adequate power with all common types of fuels available in different parts of the country. The adoption of the modified downdraught plant, capable of generating wood gas, described in this article, will probably satisfy these requirements.

Further investigation is in progress.

Acknowledgment

Thanks of the authors are due to Mr. Navin Mapara, Partner of *Messrs. Mapara Parekh Co., Bombay*, who generously built up the experimental plant according to the authors' design and gave valuable assistance in making modifications in the plant from time to time. Thanks are also due to *Messrs. Karnik and Shankerkute*, Engineers of the above firm, for their keen interest and help in the manufacture of the experimental plant.

References

- ¹ Report on the Conference of Technical and Testing Officers held in October, 1944.
- ² Kissin, *Gas Producers for Motor Vehicles and their operation with forest fuels*.
- ³ Ribers, U., *Skogsagaren*, 1940, 16, 202.
- ⁴ H. Scott Hall and M. S. Homer, *Portable Producer Gas Plant for Road Transport*.
- ⁵ W. H. Fowke, *J. Inst. Mech. Eng.*, 1939, 141, 368.
- ⁶ H. L. Pirie, *Ibid.*, 1939, 141, 365.
- ⁷ Monck, *Ibid.*, 1939, 141, 371.
- ⁸ Bowden, Freeth and Rutherford, *Ibid.*, 1941, 146, 193.
- ⁹ K. W. Williams, *Ibid.*, 1942, 141, 205.

Letters to the Editor

STUDIES IN THE CONSTITUENTS OF GERMS OF COMMON INDIAN PULSES

ONE of the authors (S.S.) in his investigations in the constituents of *chana* or Bengal gram (*Cicer arietinum* Linn) germs¹ isolated three new crystalline substances provisionally designated biochanin A, biochanin B and biochanin C, of which the constitution of the first one was established as a new isoflavone². Similar investigations have been carried out with the germs of *Kabli chana* (*Cicer arietinum* Linn.—white variety), mung (*Phaseolus mungo* Linn), urd (*Phaseolus radiatus* Linn.), pea (*Pisum sativum* Linn.), and soybeans (*Soja hispida*).

From the germs of *Kabli chana*, products identical with biochanin A, biochanin B and biochanin C have been isolated. The yield of biochanin A and biochanin B is about five times that obtained in the case of Bengal gram germs. The identity of the two sets of substances was established by observing the mixed melting points of the substances, and in the case of biochanin A and biochanin B further confirmed by observing the mixed melting points of the acetyl derivatives.

A small quantity of a crystalline material has been isolated from the *mung* germs, but it has not yet been sufficiently purified. The germs of *urd* and *pea* did not yield appreciable quantities of any crystalline product.

The germs of *soya beans* yielded two crystalline substances melting at 316-17° C. (darking earlier) and 323-24° C. respectively. Fuller details will be published later. Further work with the germs of other common Indian pulses is in progress.

Laboratories of the Council
of Scientific and Industrial
Research, Delhi.
10th October, 1945.

J. L. BOSE.
P. R. BHANDARI.
S. SIDDIQUI.

¹ Siddiqui, *J. Sci. Ind. Res.*, 1945, 3, 68.

² Bose and Siddiqui, *J. Sci. Ind. Res.*, 1945, 4, 231.

FLUXES FOR WELDING ALUMINIUM

We were extremely interested to read the account published in the May issue of the *Journal*, dealing with a new flux that has been evolved for the welding of aluminium.

We have received a sample of the flux made up to the composition given, and have carried out practical tests, both in our own Welding Shops in India and in those of our Parent Company, in the U.K. The general consensus of opinion is that, although sound welds can be made by a skilled and experienced operator, in the hands of the normal welder it is extremely difficult to manipulate. There is a tendency for excessive penetration and entrapment of the flux in the weld. The best results were obtained by painting the flux on the edges of the seams to be welded and on the rod, and also slightly preheating the rod with the blowpipe flame. We should be chary of placing this flux in the hands of an unskilled operator.

N. DANIEL.

*The Indian Oxygen and Acetylene
Co., Ltd.,
Calcutta, 25th September 1945.*

[The work on welding fluxes was taken up in the laboratories of the *Council of Scientific and Industrial Research*, primarily to help the war effort, and to formulate from easily available indigenous materials a satisfactory composition. The product finally evolved was reported to be satisfactory by the U.S.A. Air Force. In fact, one of the officers of the Air Force was working in the *Council Laboratories*, and he took keen interest in this investigation. The difficulties experienced by unskilled operators, referred to in the above note, is understandable. We hope there will be no dearth of skilled workers in this country!—Ed.]



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INDIAN UNIVERSITIES—BASIC NEEDS AND FUNCTIONS

SIR Maurice Gwyer's address at the Annual Convocation of the Agra University (24th November 1945) will be read with interest and profit by all the educationists in this country. The topics discussed in the address are of vital importance to the progress of university education as a whole. University reform is in the air to-day, and the discussion on the future of higher education in this country cannot but prove valuable to the formulation of plans and programmes for attaining the higher values of university education.

Status of Teachers

Dealing with the conditions in India, Sir Maurice Gwyer referred to the status and prospects of university teachers. The reputation of a university and the recognition which it receives outside, depend on the quality of teaching given to its students and on its research achievements. Every university aspires to lead its students to the highest standard of mental development and discipline, and for achieving this objective the quality of the teaching staff must be the highest. Mediocrity should not be tolerated. Men of character and attainment should be attracted to the universities and retained in service. This will be possible only if there is an adequate recognition of the status of the teacher. Sir Maurice observes:

"There is going to be no real advance in education whether in universities or elsewhere, unless the key position occupied by the teacher is adequately recognized and

a proper status accorded to him. When I speak of a proper status, I mean that the teacher should enjoy conditions of service comparable to those which are enjoyed by others who discharge public functions of equal importance; and conditions of service include not only decent remuneration but reasonable opportunities for leisure and self-improvement and prospects of a useful and honourable career. It is unhappily only too true that the position of teachers in many universities and in a still greater number of colleges in India falls far short of this ideal."

Taking first things first, in any scheme of university reform, the status of the teacher demands immediate consideration. The teacher's responsibilities are so many and so important, that for discharging them satisfactorily, he must devote his very best attention, undistracted by hardships which afflict a large number of them at present. It is essential to improve the conditions of service to enable him to carry out his professional work efficiently and honourably.

Research, the most important Function

The view that the university is a great deal more than a teaching body, that it is pre-eminently an institution for the cultivation and promotion of human knowledge is by no means new. The university teacher has the obligation to extend the frontiers of charted knowledge in his own field, in whatever direction such extension is intellectually satisfying to him. Referring to the

functions of a university, Sir Maurice Gwyer observes :

"The most important function of all is, in my judgment, the extension of the boundaries of knowledge, which is what research in the true sense means. It is the enthusiasm for the increase of human knowledge which makes a university a living and growing organism. Without this vital spark, it tends to become a machine for the imparting of knowledge acquired elsewhere I doubt if this conception of a university is fully appreciated as yet, as it ought to be, in India, where the teaching function with a view to qualifying students for degrees has been apt to predominate. I do not think that the universities will be able to play the part they should in shaping the destinies of a nation unless the importance of this other function is recognized."

The conception of a university as a living and growing organism cannot be over-emphasized. In a changing economic and social environment, the university is called upon to shoulder new responsibilities and new obligations. It should stimulate economic and social progress. To meet these obligations the university must be an active centre of research and serve as the main source of supply of research workers required for developments in economic and cultural subjects.

Quality, an important Consideration

The quality of students that enter a university is no less important than the quality of the teaching personnel for attaining the objectives of university education. "Too great a proportion of students go to universities who are unlikely to benefit by a university education and training," says Sir Maurice. It is equally true that there are great numbers of young men who possess the ability but not the means to enter a university. The position has been clearly stated by Dr. Vannevar Bush in his recent report* to the President of the United States of America.

"There are talented individuals in every segment of the population, but with few exceptions, those without the means of buying higher education go without it. Here is a tremendous waste of the greatest resource of a nation—the intelligence of

its citizens. If ability and not circumstance of family fortune is made to determine who shall receive higher education in science, then we shall be assured of constantly improving quality at every level of scientific activity."

It has been repeatedly urged in the reports of the Education Department of the Office of the High Commissioner for India in London, that a considerable number of students go to the United Kingdom every year without the necessary background for enabling them to profit by the courses of study which they wish to take up. There is every year a large number of failures in the university examinations. These are clear indications which make it imperative that high standards should be set up for the selection of students for admission to the universities. No one should be debarred for lack of means; nor should the university be cluttered by those who are unable to profit by the training imparted. The university as the guardian of standards will not be able to discharge its functions unless it is assured of a high quality of character, personality and intellect of its personnel—both students and staff.

Funds Required

Large sums of money are required for providing the students with the best of conditions for work, tuition by highly qualified and technically skilled masters, well equipped libraries and laboratories, buildings such as union premises and halls of residence and playing fields for recreation. Elaborate and expensive equipment is required for research. Research costs have steadily risen. Paucity of funds, not paucity of plans, has led to stagnation in university education. Sir Maurice points out that "Governments, past and present, have failed to recognize that of all forms of expenditure, that on education is almost the last which deserves to be called non-productive." He is of the opinion that men of wealth in India "of whom there are a large, and of late years, a growing number," must come forward to support advanced learning. With a few shining exceptions, men of wealth are apt to support applied research, the results of which are of a definitely practical and commercial value. It has been stated that Governments as "guardians of the public purse are apt to take a strictly practical view and desire to be assured of practical results,"

*Science—the endless frontier, 1945.

and that it would be difficult to persuade them to spend money on "pure learning and pure research." It is widely recognized that even according to the 'strictest practical view,' expenditure on pure research yields great and often revolutionary results of value, and if the trends in the United Kingdom and the United States of America are a guidance, it is the responsibility of Governments to foster pure research which is basic and fundamental to an all-round development of the nation. Basic research is non-commercial in the sense that it does not lead to immediate improvements in processes and products, and such research is not likely to receive much attention if it has to depend on those who have acquired wealth through industry. It is the Government that should support academic learning and academic research, and such support may be supplemented by private endowments if they are made without conditions which affect the autonomy of the university.

Liberal Education Essential

One of the causes that led to the recent world crisis, is the system of education that was adopted in several parts of the world. Education should be so planned and organized that it should "raise us above racial, political and religious antagonisms and socialize our instincts."* In influencing educational plans, programmes and policies, the universities occupy the top position. By kindling the flame of true scholarship and inculcating in the minds of the youth a sense of moral values and spiritual principles, they can foster a truly international outlook, which is so essential for peace and progress. Every consideration points to the conclusion that the vigour and the outlook of the educated classes largely determines progress. Sir Maurice Gwyer has stressed the requirements which would improve the quality and tone of higher education in India and his enlightened views demand close attention.

*Convocation Address, Patna University, 1945.

THE ROYAL INSTITUTE OF SCIENCE, BOMBAY

SILVER JUBILEE CELEBRATION

THE motto, "It is good to seek out the causes of things," represents most appropriately the high endeavour which animates the work of the staff and students of the Royal Institute of Science, Bombay, which celebrated the Silver Jubilee of its foundation on 15th November 1945. The Institute owes its inception to the initiative of the enlightened public of Bombay, who realized in the early years of this century, the need for establishing, in the metropolis of the Presidency, an institution solely devoted to the teaching and advancement of scientific knowledge for grappling with the complex problems of industry, public health and social security. The benevolent citizens of Bombay contributed liberally to the establishment of the institution. The building was

completed in 1915, but the Institute began its active work only in 1920.

The Royal Institute of Science is a Government institution affiliated to the Bombay University for all the Degrees in Science subjects. Its aims are: (i) to interest the public in science, (ii) to teach science to the undergraduates, (iii) to provide facilities for research, (iv) to co-operate with other institutions engaged in research work, and (v) to assist industry by elucidating their immediate and long-range problems. The Institute has fulfilled these aims with distinction, and during the past quarter of a century, it has taken a leading part in the development of post-graduate teaching and research in the Presidency. The different scientific departments of the Institute have

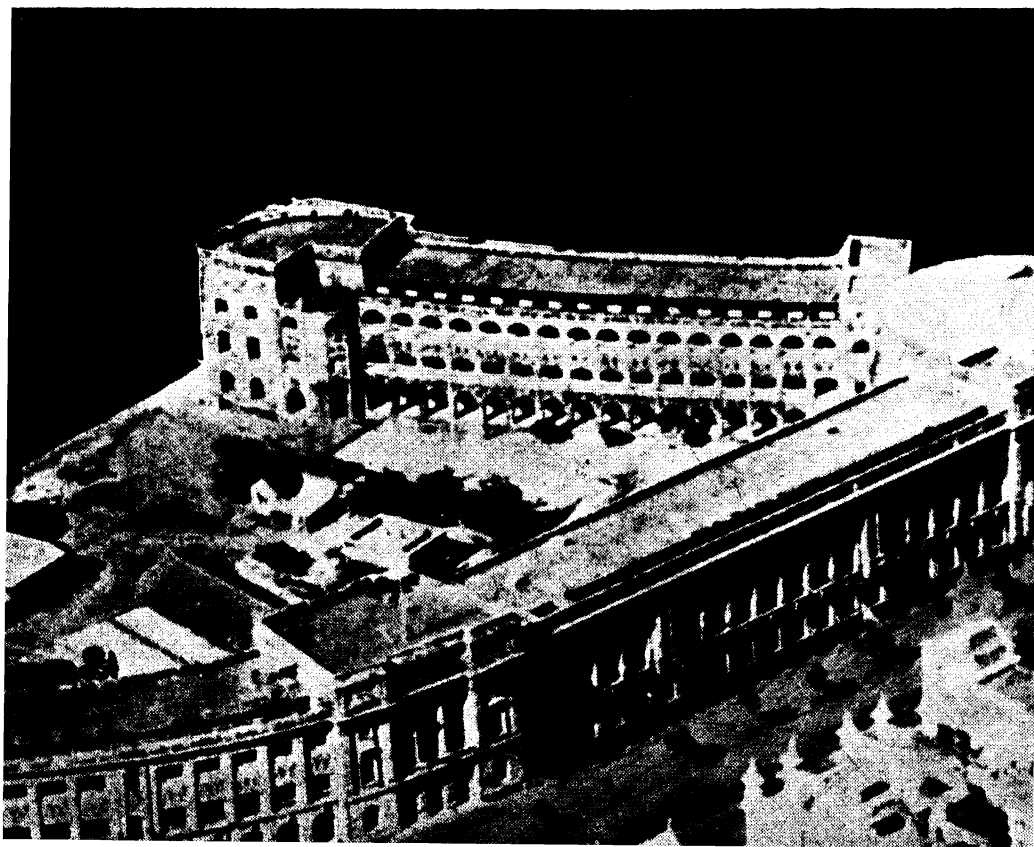
maintained a high standard of scientific endeavour, and no less than 450 research papers and memoirs have emerged from its laboratories during these years, a record of which any institution may well be proud.

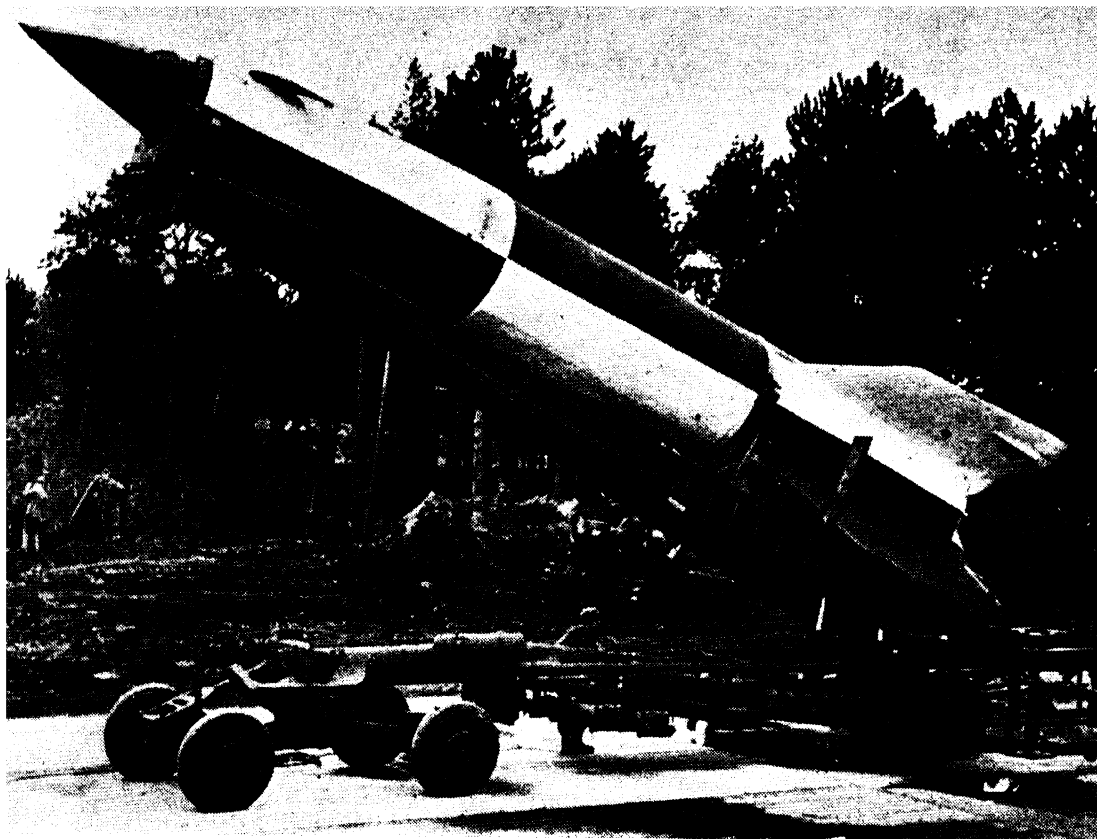
The opening ceremony of the Silver Jubilee was performed by H.E. Sir John Colville, Governor of Bombay, and the Inaugural Address was delivered by Sir Shanti Swarup Bhatnagar. The Commemoration Volume of the Jubilee, besides containing the history of the Institute, the reminiscences of the past students and staff, and appreciations of the work of the Institute by leaders of science and public affairs, gives an outline

of the impressive research work carried out in the Institute since its inception. The science exhibition organized during the Jubilee Week attracted wide popular interest and brought home to the public the main features of the research achievements of the Institute. Popular lectures by distinguished men of science formed an important feature of the celebrations.

The Royal Institute of Science, Bombay, has made significant contributions to India's scientific development. Its past achievements hold promise that its reputation as a centre of fruitful scientific pursuits will be greatly enhanced in the years to come.

Royal Institute of Science, Bombay.





GERMAN WAR RESEARCH AND DEVELOPMENT

II — WAR WEAPONS

THE technical reports of the Field Teams of the Combined Intelligence Objectives Sub-Committee (C. I. O. S.) provide a wealth of material on German military research and development and the new war weapons which were either under operational use, or were in the process of development for operational use. A catch of approximately 5 tons of "Top Secret" documents covering the entire field of German arms development and industrial mobilization for war was seized in a salt mine near Gotha while S.S. men were trying to destroy it. The entire files of the German Patent Office consisting of 250,000 volumes were discovered in an abandoned mine shaft. This collection of documents is expected to yield vital information concerning intelligence. The investigation of *Krupps* at Essen, the proving range at Hillersleben and *Rheinmetal Borsing* at Dusseldorf, has revealed a large number of documents relating to design, research

and development on German weapons and projectiles together with their ballistics. Data on rocket assisted projectiles, experimental shells for use in the German "Squeeze" gun and rifled shells are considered to be of particular importance. The information concerns the whole range of weapon development for automatic weapons to experimental guns of 60 cm. calibre. Some of the development work concerned types hitherto unknown. The capture of practically all the German experimental firing range records provide data of the highest importance. The investigation of the *Hermann Göring Institute* at Braunschweig has provided access to a great concentration of research and development on advanced jet-propulsion, aerodynamics and long-range guided missiles. Its exploitation has been carried out over many months by leading scientific and technical personnel who were flown from the United Kingdom and the United

States of America. An elaborate installation for the testing of jet propulsion units and pilot models proved to be of particular interest and much new information concerning advanced aviation, rocket and jet fuels was obtained from this target. Several key men of the German armament and planning establishment have been interrogated and information on many aspects of German war economy has been collected and assessed. These investigations are of the highest importance as they provide information of value on weapons which may imperil the future security of the United Nations and on technical discoveries which will assist the United Nations in their own development.

Aircraft

The Messerschmitt organization may be said to have embraced the entire German nation. Branch works were to be found everywhere, making fuselages, nose structures, rudder surfaces, landing gear and other parts. Me-262 was first built in 1939. It was propelled at that time by two Daimler-Benz motors. Pressure was brought on Junkers to produce jet-motors in 1943. The production of jet-propelled planes got under way at the end of 1943. Sixteen planes were produced for a fighter squadron in May 1944. Production figures were never attained, chiefly due to Allied bombing of the factories. The figures for Me-262, for the first four months of 1945 were respectively 160, 120, 230 and 230, although the target aimed was 750 per month.

A bombproof Messerschmitt assembly plant, *Weingut II*, was under construction, near Landsberg. The structure at the time of investigation was 30 per cent. complete. It was designed to house a four-story assembly plant complete with power house, ventilating system, railroad siding and loading platform. Completed planes were to be catapulted from the building and land at some existing airport.

Me-262 was the latest Messerschmitt plane placed on production and perhaps best represents the Messerschmitt approach to the design of hydraulic systems and pressure cabin. Interrogation of the Messerschmitt personnel revealed full details. It would appear that Messerschmitt was far behind Allied development in the field of pressure cabins. Canopy defrosting and demisting had been approached, among other ways, by the use of multiple glass

panes with fine electric heater wires between panes. While successful for defrosting, it did not correct internal misting and relatively high airflows through the cabin to keep humidity down was found to be a much better solution.

A swept back wing believed to include the characteristics of the wing of the rocket driven Me-163 was fully investigated. A specially designed wing for the use of boundary layer control in conjunction with flaps had also been developed.

Me-328 was powered by two Argus Rohr units as in V-1. It flew as a glider and also as a powered unit.

Dornier Werke : The main Dornier development during the past two years was the Do.335 which was brought out to curb the excessive combat losses experienced on Do.217. Do.335 was first designed as an attack bomber in 1943 ; it was modified to a single-seater fighter to develop a speed of 760 km./hr. with guns, armour and bombs installed. The DB 603E engine was the latest production engine designed for the nose of the 335. The DB 603Q, especially designed for the Do.335, was installed in the tail. The DB.603 engine with exhaust driven turbo superchargers was of interest. A special hard chrome knurling process was employed (*Gnome and Rhone*) for cylinder barrels and provided new information on German engine development. Do.335 was being reworked for night fighter applications. The main revisions involved a wider cockpit for two persons, radar equipment and wood outer wing panels to facilitate radar installation.

Dornier had fabricated a pressure cabin airplane, the Do.217P.

The *Junkers Werke* at Dessau, was mainly interested in the production of engines. A number of planes were also produced, among which was Ju.87, a Stuka, the production of which had reached 4,000 by 1940. At the climax of the Battle of Britain, 100-150 stukas were leaving the plant every month, and the production continued to rise until the terrific superiority of the Allied planes brought about gradual cutbacks in production by the beginning of 1943. Only a few stukas were being sent to the Eastern front after that year.

Ju.390 was the counterpart of the Allied four-motored bombers. It was a huge six motored plane, but after the 15th machine

had been completed, the production was given up because of the great amount of material required.

Considerable work had been carried out on high altitude soaring, making use of the waves set up by cold masses of air moving relative to each other. This had led to high altitude and high Mach number problems in general, and to the development of a series of aircraft such as DFS 228, DFS 1068, DFS 346, DFS 332 and Me-328.

DFS 228 was a large single-seat glider with a liquid rocket of the "cold" Walther type in the tail. It was carried pick-a-back on Do.217 to 10,000 metres height and released. It climbed under its own power to an altitude of 24,500 metres. A second aircraft was built with a prone pilot and a jettisonable nose. Both aircrafts had pressure cabins.

DFS 1068 was an aircraft with wings of 0°, 25°, and 35° sweepback to determine the optimum amount of sweepback for both low and high speed flight. To any of these combinations four jet units (BMW 003 and He 011) could be fitted, either four under the wing or two under the wing and two aft the fuselage near the top. Speed in the vicinity of a Mach number of one at altitudes of 7-12 km. was expected.

DFS 346 was still in the design stage. It was powered by two Walther rocket units and was expected to reach a Mach number of 2.6 at 100,000' altitude.

DFS 332 was a "measuring aircraft." It had a twin boom arrangement and the whole rectangular wing between the booms rotated relative to the booms. This part of the wing was used to test various wing profiles at high speed. The aircraft was towed to altitudes, and it was proposed to install jet units in the fuselage below the booms to attain high speed.

B.P. 20 (Natter) : The B.P. 20 aircraft was a small rocket-propelled interceptor planned for the purpose of providing defence for vital targets when attacked by large Allied formations. It could take off vertically and after the completion of the attack, it was abandoned by the pilot who landed by a parachute. It was so designed that it could be produced in large numbers in small wood working plants, and the elimination of normal take off and landing reduced the training of pilots to a minimum. The aircraft was still under development.

The rocket used was a standard Walther unit 109-509. Two cordite rockets were attached on the outside of the fuselage at the tail end. These were the SR.34 rockets giving 12,000 kg./sec. impulse. The rocket was of the coated type with internal star-section charge using a 48 mm. dia. nozzle in the summer and a 42 mm. dia. nozzle in winter. The nozzles were inclined outwards to keep the jet clear of the fuselage. The power unit used the T. Stoff and C. Stoff for which tank capacities of 450 litres and 250 litres were provided. This corresponded to 600 kg. of fuel and was sufficient for 80 secs. at full power. The aircraft was fitted with a honeycomb for 24 electrically fired rocket shells of 7.3 cm. calibre. It was proposed to increase this number to 48. The aircraft was 5.72 m. long and weighed 1,710 kg. It could reach a max. height of 12,000 metres with a normal cruising speed of 800 km./hr. and a duration of 2 minutes flight. The launching apparatus, known as "Lafette" consisted of a single pole, 16 m. high in a concrete foundation 2 m. deep. Lugs on the fuselage and fins moved in a channel on this pole and additional support was provided by flat strips parallel to the pole which were in contact with slides under the wings. The aircraft was shot off with an initial acceleration of 2.2g. towards the enemy bomber. In guiding the *B.P.20*, towards the enemy bomber formation, a system of radio control was contemplated.

The Flettner Helicopter : Type Fl. 282 with two rotors combining into one another had proved to be the most successful and perfect helicopter. They were being used by the German Armoured Forces in trials at the front. An order for 1,000 Helicopters had been placed, but could not be executed owing to Allied bombing. The Helicopter provided surprising manœuvrability and security of flight. It could be flown under all weather conditions, could land and take off on a rolling, pitching and stamping ship. Landings had been made on a gun turret of a cruiser in rough sea. They were planned to take part in anti-tank artillery observation. The Fl.282 was fitted with a small sports motor, SH24, of about 150 H.P. and could transport 2-3 persons. Petrol consumption was about 38 litres per hour ; peak height. 4,000 metres ; max. speed 160 km./hr. ; and travelling speed about 120 km./hr. It was specially

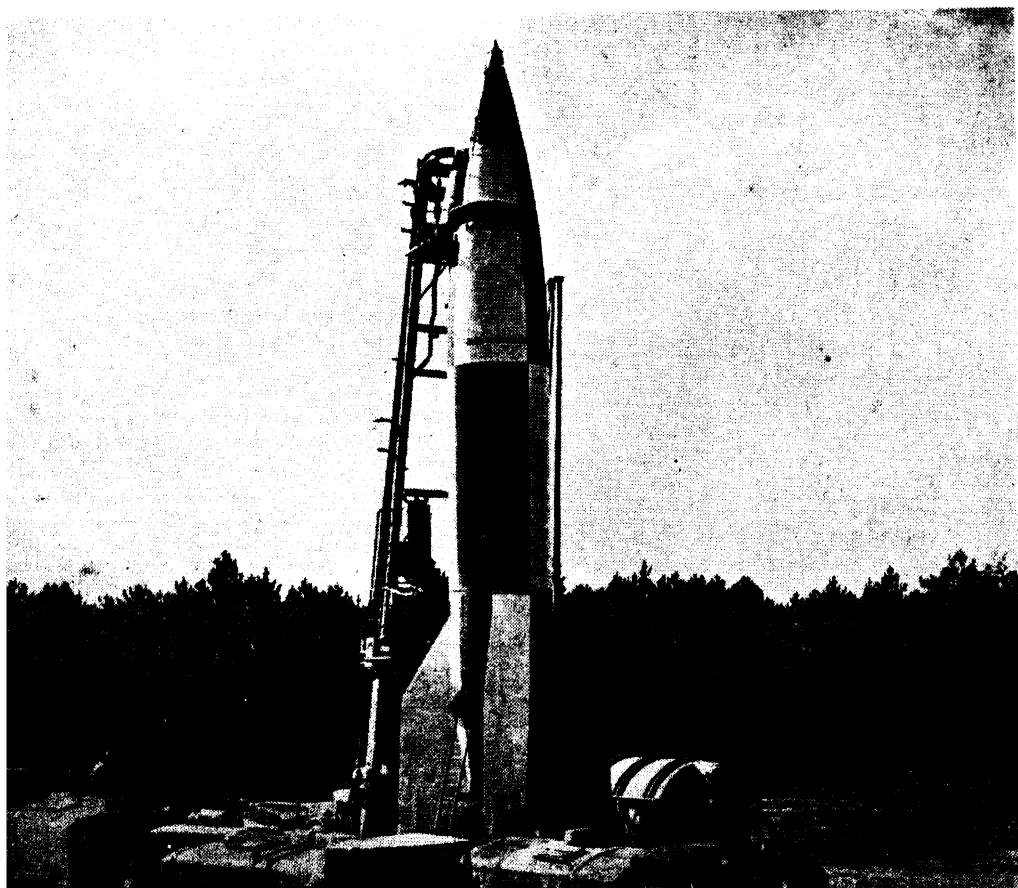
suited for the construction of flying motor cars and buses. Fl.339 which was being designed by Flettner was considered to be an improvement incorporating the experience gained with Fl.282.

Complete details were obtained about the Dornier 24 flying boat.

The *Flugtechnisches Fachgruppe* at Prien on Chien See, was interested in the development of a completely new aeroplane-type in co-operation with Dr. Lippisch of Vienna, in order to conquer the stratosphere and attain supersonic speeds. In consequence of low air density at high altitudes, the load capacity of the aeroplane could only be utilized if necessary lift was attained by high flying speed. In order to increase the speed of an aeroplane of standard construction, a long and sustained development would be necessary. A different construction, therefore, became necessary. It was soon realized that it was not difficult

to construct an aeroplane for supersonic speeds only, but it was very difficult to design one which could fly both in subsonic and supersonic ranges. A plane (DM1) built in wood with a symmetrical elliptical profile was designed for the purpose. The wings and tail were developable surfaces and cantilever shells without spar. The wing was not twisted and was without dihedral. Regarding the power plant, it was known that it would be impossible to attain the performance necessary for supersonic flight with a standard power plant and propeller. Supersonic speeds could be attained by rocket propulsion as in the Messerschmitt-163 (*Komet*). The rocket propulsion would be economical at flying speeds of more than 1,250 miles/hr. It was proposed to test the model, first without a power plant by towing in "Huckepack" by a normal plane to 8,000 to 10,000 yds. and released to test the qualities of slow

A view of the rocket in the vertical firing position surrounded by fuel lorries.



speed flight. The model could be powered by jet-propulsion to attain a speed of 500-750 miles/hr. and finally with power plants to give speeds of 1,250 miles/hr. The theoretical aspects of wing design, etc., had been worked out thoroughly.

In the field of engine production the 211 E and F types were produced by the Junkers. About 4,000 of them were produced per month. The jet 004 was produced at the total of 1050/month since March 1944. A total of 6,000 engines had been produced since the introduction of this type.

A new type of turbine blade was used for the Junkers 004 engines. Complete information regarding its manufacture has been obtained.

A few tests had been made with a coal burning *Athodyd* mounted on Do.217.

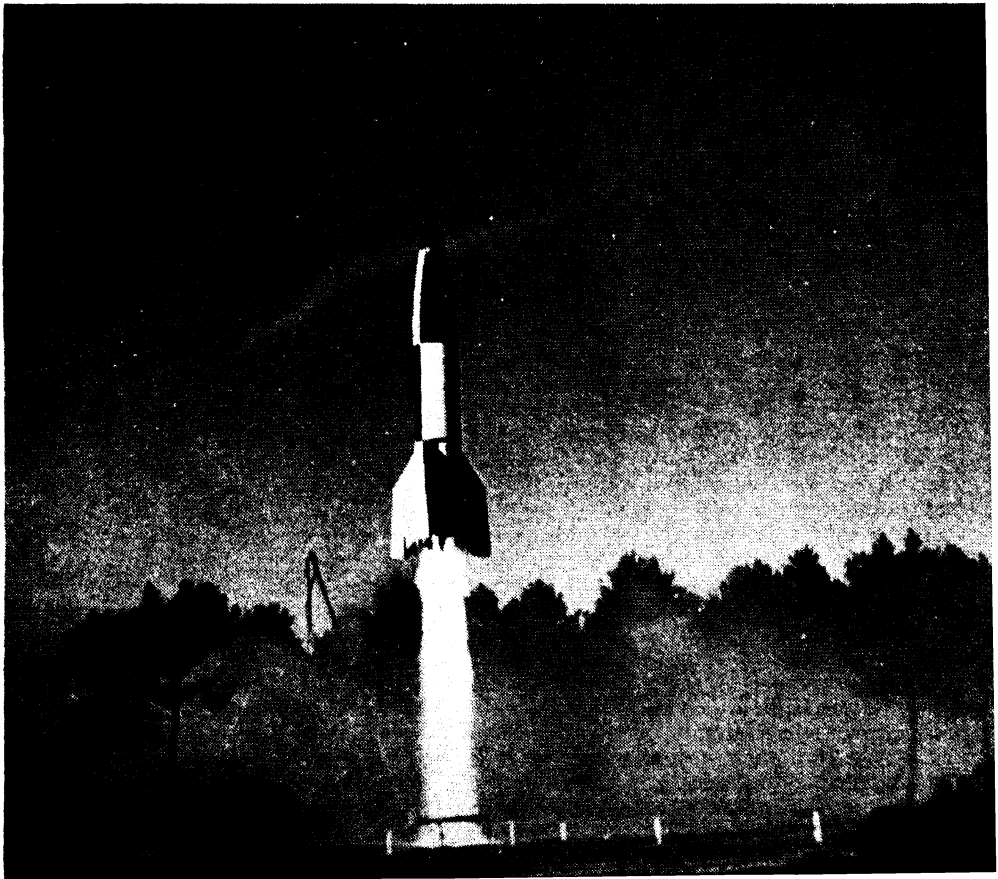
At Prien and Ainring, the *Deutsche Forschungsanstalt for Segelflug*, hangars with

experimental aircraft, DFS 228, He 280 without jet units, V-P's Hs 293 and workshop were located. This establishment had carried out a large portion of German research on glider towing pick-a-back combination, glide bombs, special aircraft for high altitude (60,000' and higher) and high Mach. number research, the application of rocket *athodyd* (coal-fuel) and Argus Rohr power units (as in V-1) for aircraft, remote control of winged bombs and missiles, automatic pilots, television used in conjunction with remote control of guided missiles and meteorology of high altitudes. Work was also done on dropping of containers including a motorboat carrying three men.

A primitive television device in the nose of DFS 230, relayed back the target to a screen in the aircraft, and the 230 was steered towards the target from Ju. 52.

The investigations have revealed that, in general, Britain had maintained a lead over

A view of the rocket at the commencement of flight.



Germany in aero engines. The German efforts to alter designs of planes developed for one purpose and make them also suitable for other purposes, had definitely given a setback to production. For instance, dive bombers became fighters, then long-range fighters, then long-range fighter bombers, and so on. The result was such planes could not reach optimum performance in any one role and were, therefore, outclassed qualitatively by Allied planes which were specially designed and built for single purpose.

As the attack of Allied aircraft gained in momentum, German effort was concentrated on anti-aircraft devices. The enormous amount of work on long-range guns was an attempt to compensate for lack of Air strength. Some 30 per cent. of the output of guns in 1944 consisted of *flak* guns, while 20 per cent. of the year's output of the heavier calibre ammunition (for 7 cm. upwards) consisted of AA shells. 50-55 per cent. of the armaments production capacity of the electro-technical industry was engaged in the manufacture of radar and signals equipment for defence against bomber attack. 33 per cent. of the optical industry was engaged on the production of aiming devices for AA guns and of other anti-aircraft equipment.

Tanks

The German tank programme was influenced by three major factors. The first of these was the desire for powerful guns and thick armour. The development of 30-35-ton tanks was begun in 1938 and production anticipated in 1942. With the invasion of Russia in 1941, where the original Russian tank T-34 was encountered, the German Army Staff decided to abandon the then development programme and demanded the production of heavy tanks. As a result *Tiger I* and *Panther* designs were developed and production pushed through. The *Panther* represented the most successful tank design of the war. The second factor that influenced German tank design was the trend towards gun-carriages of limited traverse. The number of lighter tanks equipped with limited traverse guns permitting the mounting of larger guns constantly increased. Lastly, economic considerations dominated tank production. The German tank programme was extravagant in man-hours due to lack of mass production knowledge. The design programme was never rationalized, and in

some cases, the designs were unnecessarily complicated.

General tank efficiency was gained in 1943-45 by a tremendous technical effort by a powerful team of experts drawn from industry. This resulted in the production of *Tiger II* and *Panther* which are regarded as the best tanks in the world to-day.

The *M.A.N.* firm at Nuremburg had a splendid vibration laboratory under the direction of Prof. Lehr. Tests were carried out in the laboratory on torsion bar springing, leaf springing, spiral springing, etc., in order to determine the type of springs best suited for tank suspensions.

The Army development was the 1,000-ton tank developed by *Krupps*. The tank was in reality a land Battle Cruiser, 23 metres in length with four turrets each carrying two 12.8 cm. guns and six tracks. The *Krupps* tanks would have actually weighed 1,800 tons. The idea was, however, given up. For tank construction, 75-80 tons were considered to be the limit.

Investigation of the Henschel Tank Army Ground, the most scientifically equipped, automotive proving ground for tanks in Germany, revealed the pilot model of the E-100 tank weighing approximately 100 tons. It was designed to mount a 12 cm. gun on the turret. A pilot of the "Selbst-fahr-lafette," a lightly armoured self-propelled gun-carriage, was also seen. A deep fording pit, about 25' deep and large enough for tests on complete tanks entirely submerged in water was discovered. Reports relating to the tests on *Tiger II* during under-water operation were disclosed. The ford had arrangements for instrumentation while under water and various safety devices such as diving suits and a means for draining the pool quickly in case of emergency.

The existence of the *Maus*, a heavily armoured tank designed to weigh 150 tons, but actually weighing 200 tons, was disclosed during the investigation of the target. The *Maus* was powered by a 850-1000 h.p. V-12 air-cooled engine and was designed for strategic mobility directly on rails.

A large amount of development work was carried out on the general problem of night vision. Dr. Hans Ritz of *C.F.H. Müller* at Rontgenstrasse, Hamburg, had perfected an infra-red tube, which when used in tanks, blind and tactically useless at night, could be made to "see in the dark." This was made possible by an infra-red receiver and

an infra-red searchlight, the latter being fitted to the tank or independently operated from a flank of "artificial moonlight." The range of the set, when relying on the radiated heat as opposed to recording and image illumination by an infra-red lamp, was 10-15 kilometres under good conditions.

At *Zindapp Werke*, Nurnberg, a self-propelled electrically controlled small demolition tank (*Goliath*) had been designed.

Assault guns were preferred to heavy tanks for defensive warfare, as favoured by its thinner side armour, it was light and could carry more ammunition. The introduction of the non-recoiling guns for assault gun equipment was an important development. This development took about a year and it was only in April 1945 that the first 10 equipments so fitted were sent to the battle front.

Engines (Mayback HL 230) of improved reliability with respect to cooling (2 pumps), coolant distribution, bearings, cylinder head seal, etc. had been designed for tanks. The power output was increased at first from 650 h.p. to 800 h.p. by direct fuel injection and increased compression ratio, then from 800 h.p. to 900 h.p. by supercharging. The hydraulic system of transmission was favoured. A transmission system employing a number of epicyclic trains was being considered. Rear drive was preferred by the Army from a combat point of view to reduce vulnerability. The use of resilient wheels resulted in an increase of wheel life compared with rubber-tyred wheels, and did not shorten track life or occasion trouble with bearings.

A new tank engine, designated HL 234, having direct fuel injection, had been developed. The maximum h.p. developed was 900 without supercharging, using the regular German Army fuel of 70-74 octane rating. Investigations were on hand for the development of solid fuel injection engines, which could realise an increase in output of the order of 30 per cent. as suggested by Hedekamph, and what was valuable was the 40 per cent. saving in fuel consumption at half load.

U-Boats

Complete information regarding German naval vessels, equipment and documents have been obtained. Among this is information regarding the German Destroyer DD 2-37, including new type of gear, the *Narvik* class Destroyer using high steam pressure and midget U-Boats. The U-boats in the German Navy were *Type 7c* (500 tons

std. displ.) *Type 9c* (800 tons std. displ.), *Type 10b* (minelayer, about 1,500 tons std. displ.), *Type 14* (tanker, about 1,000 tons std. displ.), *Type 17* (abt. 250 tons std. displ.). These boats have Walther H₂O₂ high underwater speed propulsion), *Type 20*, (cargo, about 2,000 tons std. displ.), *Type 21* (abt. 1,500 tons std. displ.) and *Type 23* (about 300 tons std. displ.). Midget U-boats: *Seehund*, *Types 278* and *127* (2 men, 2 torpedoes, about 15 tons std. displ.), *Melch* (1-man, 2 torpedoes), *Marder*, (1-man, 1 torpedo), *Hai* (1-man, 1 torpedo) and *Biber* (1 man, 2 torpedoes). The midgets were operated from large U-boats; 4 of them could be carried on the deck of 1 large U-boat. Brush type camouflage attached to the periscope, was employed. Information of interest was the Schnorkel installation. It was of the vertically operated rack and gear type. The heads of some were rubbercoated for anti-radar. Some of the installations were of the hinged type and streamlined.

Among the surface vessels inspected were *Admiral Von Hipper* (heavy Cruiser, 10,000 tons, std. displ.) and its sister ships *Blucher* and *Crusier Koln*, the *Narvik* class of Destroyers, Minesweepers *Spaarbrecher*, (M-type and R-type), magnetic Minesweeper, *Type HFG 50*, Minelayers, E-boats (characteristic of the latest type being 20 cylinder diesels, three 2,500 h. p. motors to give 42 knots, 35 metres long), *Deutschland* (10,000 tons std. displ.), *Karlsruhe* and *Nurnberg*, (6,000 tons std. displ.) *Gneissau* and *Schornhorst* (Battleships, 26,000 tons std. displ.), *Graff Zeppelin* (Aircraft Carrier, 21,000 tons std. displ.), projected light cruisers "M" and "N", and projected Battleship "O".

Considerable work had been carried out on the design of a submarine using Diesel engines for propulsion while submerged. The submarine was designated *Krieslauf*. Its operation consisted of the following cycle: Exhaust gas after a short period of operation consisting chiefly of CO, CO₂ and H₂O was led through a cooler to reduce the temperature to 110° C. and through a filter to remove solid particles. The larger part of the exhaust gas was led to a mixing chamber where it was diffused with about 20 per cent. oxygen. The temperature was maintained at 90° C. by means of a thermally controlled by-pass of the cooler. The pressure in the intake manifold was held at 1 atm. The remainder of the exhaust gas passed through a second cooler and then

to a compressor attached to the engine by a clutch, by means of which it was pumped overboard through a water separator. The admission of oxygen was made by a regulating valve controlled by the manifold pressure which varied the amount according to the engine speed. Another similar control operated simultaneously to discharge the excess exhaust gas overboard through the compressor. All the automatic valves were operated by hydraulic servo-mechanisms.

Regarding propulsion motors for submarines, *Brown Boveri Company* had developed a number of units, shockmounts, and turbo superchargers. A jet propulsion project was also being considered. Theoretical and experimental studies on the cause of vibrational noise in electrical motors, with special reference to main U-boat electric drives had been completed. The effect of slot shape, number and angle of pole pieces, number of air gaps, stiffness of mounting and general considerations relating to housing, stiffness, etc., on motor noise were considered. Noise was correlated with magnetic torque and moments set up in the pole pieces by the passage of slots and thence translated to motor housing. The phenomena were optimized mathematically to develop a design for a silent motor. The work represented a highly advanced approach to the motor-noise problem.

V-Weapons

The first V-weapon developed was A-4. Prof. Von Braun, who was responsible for this development, originally intended it as an instrument for cultural advance—a postal service to America. Prof. Braun had refused to develop it for war. On the question of limiting range, Dr. Braun's calculations showed that a 4,000 km. range would be necessary for shooting as far as America. Theoretically it was possible to shoot further, but if one tried to shoot further than 7,000 km. the projectile becomes a planet which circles in the universe. It was, however, within the sphere of practical ideas to increase the range from 300 km. to 4,000 km.

V-1 was an Air Force development. On the night of 16/17th June 1945, the first V-1 was fired. It failed because the launching ramp had been erected in a hurry and was not in order. A couple of nights later, the first successful firing was made and on the 26th June the V-weapon was put into production. It was first produced in the *Volkswagen Werke* until that was bombed

and was then transferred to "Porches" experimental underground factory at Tiercelet in Belgium near the German border. When Belgium was lost, the manufacture was carried out in the underground of the A-4 works in Nordhausen (Harz), where space became available.

At the *Dannenburg V-1 Assembly Plant*, five distinct types of V-weapons were being assembled from components manufactured in a multitude of plants. The plant was intended for airframe assembly, installation and testing of highly classified control gear and engine valve units including the installation of war heads and fuses. Pilot carrying types of V-1 were also being built. The Germans unquestionably expected to use V-1's in far greater number than previously seen. They had planned new tactical appliances emphasizing marine and pin-point targets and to vastly increase accuracy by the use of human pilots. For this, the selection of air crew had assumed great importance. Sport tests, mental tests and high altitude adaptation tests were carried out for pilots. A combination of benzidine and caffeine vastly increased physical capacities. 0.2 gm. of caffeine with 50 mgms. of cordizol suspended in sugar making a 2 gm. tablet provided an effective physical stimulant for 4-6 hours.

The pilot type V-1 had provision for one pilot just in front of the engine. The pilot would ride to the target vicinity and after selecting the target, fly the missile towards it until he was reasonably certain of accuracy, then lock the controls and save himself by dropping down with a parachute.

At Peenemunde four types of V-2 were being developed. Engineer Walther Riedel was interested in two new V-weapons—the *Wasserfall* and *Typhoon*. Both of them were anti-aircraft rocket projectiles. *Wasserfall* was a single radio-controlled rocket and the *Typhoon*, a device for firing 60 rocket projectiles one after the other at intervals of 1.5 seconds. The projectiles were 1.9 metres long and 10 cm. in diameter. *Fohn* was a smaller version of *Typhoon*. *X4* was a wire controlled air-borne weapon for use against other aircraft. *Enzian* was an anti-aircraft weapon similar to *Wasserfall* and although smaller, it carried the same weight of explosive but travelled more slowly. *Rheintochter* was similar to *Wasserfall* but had wings in the vertical as well as in the horizontal plane. This weapon was

considered to be the weapon of the future as it was much more stable in flight. Very many proximity fuses had been developed for use with the V-weapons.

Among the radio controlled bombs, were FX and the rocket types Hs 293 and Hs 117. The FX was a free fall bomb propelled only by the pull of gravity and the inertia of the bomb leaving the aircraft. The amount of control on the FX bomb from a release of 7,000 metres was a circle with a diameter of approximately 1 km. Hs 293 was a winged rocket propelled bomb, 2 metres long and approx. 90 cm. maximum diameter. The wing span including the diameter of the rocket was 210 cm. The maximum velocity of the bomb was 300 metres sec., somewhere near the speed of sound. The receiving equipment was designated E 30A, E 230b, E 230, E 230-1 and E 230-2. The receivers operated on different frequencies. One of them operated on a band approx. 60 megacycles, and another on 20 megacycles. They received 4 frequencies via the high frequency carrier for control. The control frequencies were 1, 1.5, 8 and 12 kilocycles. The frequencies passing through the appropriate band filters were amplified and were made to actuate appropriate relays. They allowed the bomb to be controlled in four directions, right, left, up and down. The command for explosion was given by a 200 cycle square wave. Some 20,000 receivers had been produced, and although on the two occasions they were employed, viz., on the Italian Battleship "Rosa" and against the Russian bridge across the Oder River in April 1945, they proved very successful, the German Air Force, surprisingly enough, did not use many of them. The transmitter for activating receiver controls was known as "Kohl." It had an output of 10 watts.

Several anti-aircraft radio-controlled bombs launched from the ground had been projected. The rockets were designed for launching from a tripod and its flight controlled by (1) visual observation, explosion control by radio; (2) radar viewing with a PPI indicator; explosion control by a proximity fuse and (3) direction control by visual or radar observation, and explosion control by a proximity fuse. The radio controlled proximity fuse had an antenna length of about 80 cm. It was a pulse device which caused explosion when reflected pulses were received at a certain time interval.

Wire-controlled transmitters and receivers for FX and Hs 293 had also been designed. Two Swedish steel wires 0.2 mm. in diameter and insulated by oxide coating were employed. The wires were 20 km. in length and were paid out from reels on both aircraft and bomb. The wire virtually suspended in the air with very little drag and was thus prevented from breaking. A simpler system which enabled the use of 10 km. wire was also developed. By reversing the D.C. voltage control could be had of the left and the right directions, and by increasing the current three times and reversing its polarity, control could be secured in the up-down direction of flight.

The rockets were transported in *Sonderwagen* to the firing area and the cradle was tilted until the rocket was in the firing position. The wagon could be used repeatedly.

The *Licht Autmoat G* was one of the devices employed to direct projectiles to the predetermined target by means of photo-electric cells. A large variety of aiming devices, steering devices for aircraft, trigger mechanisms for guns and telescopic and magnifying sights had been developed. The problems of guiding wireless controlled gliding bombs had been thoroughly investigated.

A turbo-jet propulsion unit was designed to replace the *Argus* tube. This gave the V-1 approximately double the range. It was intended as a power unit for multijet fighters. The maximum diameter of the unit was 500 mm., about the same as the max. diameter of the *Argus* tube. An interesting feature of the design was the provision of a pure impulse stage at the compressor inlet running at 40 per cent. of the main compressor unit, the purpose of which was to give the air entering the main compressor the necessary velocity and swirl. This allowed a higher Mach number at the entry of the 1st main stage with resultant smaller dimensions and fewer stages.

The main propellant materials used were alcohol and oxygen. The velocity and general propellant force obtained was limited, and in order to increase the velocity and range of the projectiles, the propellant effect of explosives was utilized.

Two bottlenecks for the manufacture of V-weapons were the rohren (venturies) and special materials. There was the difficulty of premature air busts, but this was gradually corrected. The production of A-4 (V-2) reached 700 per month and that of V-1 300 a month.

NUCLEAR ENERGY AND ITS UTILIZATION*

By D. S. KOTHARI

(University of Delhi)

THE harnessing of atomic, or more precisely, nuclear energy in the last phase of World War II, marks the beginning of a new era in the march of science and civilization. It was the use of gunpowder for military purposes in the sixteenth century that supplied the necessary social stimulus to the study of the laws of projectile motion in Western European countries and led to the birth of science as an organized activity. The progress of science, the disinterested search after truth and the respect for facts that it inculcates, are intimately bound with the growth of the democratic movement, and it is perhaps not altogether a coincidence that it is in democratic countries that science is in its most advanced stage. All the same, it is a tragic comment on civilization that the era of nuclear energy has been ushered in by the impact of a world war. War still provides the most potent stimulus to discovery and research!

The utilization of nuclear energy in the **atomic bomb** is in a way the culmination of a long series of fundamental investigations, experimental and theoretical, in the realm of atomic physics extending over half a century. The *tempo* of investigation was enormously accelerated during the last few years under the stress and urgency of war. The history of the atomic bomb is in effect the history of atomic physics (and also of a good part of astrophysics), and here we can do no more than indicate the milestones. These are shown in Fig. 1. To Rutherford (1871-1937), a peerless investigator of atomic phenomena, who in his profound comprehension of physical situations can be compared only to Galileo or Faraday, we owe the discovery of the atomic nucleus; to Fermi's theoretical and experimental genius, we owe the realization that the neutron (whose existence was envisaged by Rutherford about a decade before its discovery by Chadwick in 1932) provides the most effective and fruitful means for atomic transmutations; and to Bohr's superb

physical insight we owe the concepts that have illumined and inspired almost all the work in this field.

The most fundamental fact about a nuclear (or subatomic) process is the extraordinarily large value of the accompanying energy change compared to what is involved in a physical or a chemical process, where we are concerned only with the interaction between electrons (mostly the outermost electrons), the nuclei remaining altogether unaffected. (A nuclear process may be called an *alchemical* as distinct from a *chemical* process.) For example, a kg. of (anthracite) coal on combustion gives 9 kilowatt hours, while a kg. of blasting gelatine (which amongst explosives has the highest heat of combustion) gives 1.6 kwh.† As a fuel coal is, therefore, not only safer but (in fact, because of it) also energetically economical. Again a kg. of hydrogen on combining with oxygen evolves 40 kwh. But when hydrogen undergoes transformation into helium—and the energy of the *main-sequence* stars is due to this process the details of which we owe to Bethe — 179 million kwh. are liberated, i.e., 4.5 million times more energy is evolved than in the formation of water.

An atomic nucleus of mass number A and atomic number Z consists of Z protons and $N(A - Z \equiv N)$ neutrons. The binding energy of a nucleus, that is, its energy of formation, represents the energy which will be required to disintegrate it into its constituent nucleons—a nucleon denotes either a proton or a neutron. In an atom the electrons are bound to the nucleus by the Coulomb inverse square attractive force and the total binding energy of the electrons varies as $Z^{7/3}$. For a nucleus the binding energy is roughly proportional to its mass number. From this the obvious inference is that a nucleon does not interact with all the other nucleons present in the nucleus, as that would make the binding energy vary nearly as A^2 . In fact, the nuclear interaction, unlike Coulomb

† This may be compared with the kinetic energy of 8.7 kwh. that a mass of one kg. will acquire, if allowed to fall to the centre of the earth. It may also be noted that a square kilometre of the earth's surface receives from the sun about 1.4 million kwh. in an hour.

*Based on a lecture delivered at the Physics Colloquium, Council of Scientific and Industrial Research, in September 1945.

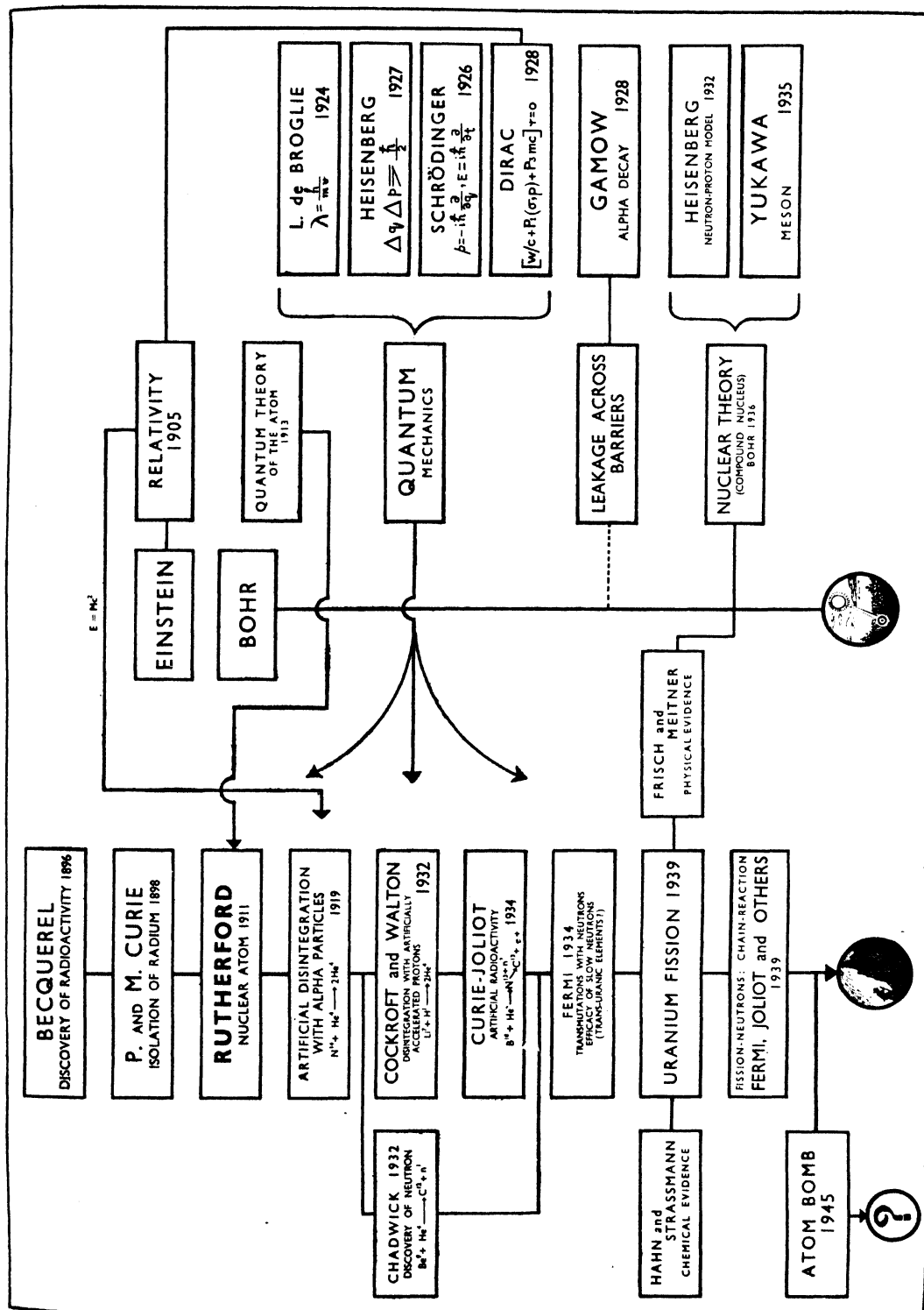


Fig. 1.

force, exhibits what may be described as saturation. In this respect the nuclear interaction resembles chemical valency. The interpretation of nuclear interaction as an "exchange force" is connected with the meson theory.

The binding energy per nucleon (which is roughly $8\frac{1}{2}$ million electron-volts (MV)) increases somewhat with increasing A , has a flat maximum in the neighbourhood of $A \sim 60$, and then decreases as A increases. The binding energy per nucleon for the heaviest nuclei is nearly $1 MV$ less than its maximum value for $A \sim 60$. This variation is the result of a competition between what may be regarded as a "surface-tension effect" and the Coulomb potential energy of the protons. As the binding energy per nucleon is largest for $A \sim 60$, the heaviest nuclei are energetically very much unstable; a nucleus of $A \sim 200$ would on fission into two nearly equal fragments liberate energy comparable to $200 MV$. A detailed examination of the situation by Bohr and Wheeler in a paper of fundamental importance (*Phys. Rev.*, 1939, 56), shows that uranium on fission into 46 Pd₁₁₉, 120 would release $200 MV$. The product nuclei would be themselves unstable against beta-decay—they contain for a given A far too many neutrons than what gives the maximum binding energy—and would liberate $31 MV$ during beta-transformations. A few neutrons are also liberated during fission. For tin the total energy-release on fission is $22 MV$, whereas for nickel it is negative ($-9 MV$), i.e., Ni is energetically stable against fission. (It is needless to add, that to disrupt a heavy nucleus into its constituent neutrons and protons would require energy of a few thousand million electron-volts.) From uranium to tin the nuclei are energetically unstable—they would liberate large energies on fission. The question now is, why do they not spontaneously explode? Why should elements heavier than tin exist at all?

A ball resting in a tumbler, is in a state of higher potential energy compared to one on the floor, but to reach the floor it must first

acquire energy to cross the wall of the tumbler. In a heavy nucleus, though fission is energetically possible, it does not occur spontaneously as the nucleus is stable against small deformations. For fission to take place the nucleus has first to be excited (it must be deformed beyond a certain critical stage) and this excitation energy is very sensitive to the value of Z^2/A . This may be easily seen as follows:

As the radius of a nucleus of mass number A is $r_0 A^{1/3}$ where $r_0 \sim 1.4 \times 10^{-13}$ cm., the increase in surface area when it breaks up into two equal fragments is $4\pi r_0^2 A^{2/3} (2^{1/3} - 1) = 0.26 \times 4\pi r_0^2 A^{2/3}$. On a naive view of the situation, the critical deformation energy (E_f) may be assumed to be the product of the increase in surface area and the "effective surface tension" of the nucleus. The effect of nuclear charge on deformation energy may be conceived as a lowering of surface tension from a value S to an effective value S' where

$$\frac{2S'}{R} = \frac{2S}{R} - 2\pi \left\{ \frac{(Ze)^2}{4\pi R^2} \right\}^2 \text{ or}$$

$$S' = S - \frac{e^2}{16\pi r_0^3} \frac{Z^2}{A}, \text{ where } e \text{ is the electron charge.}$$

We, therefore, have

$$E_f / 4\pi r_0^2 S A^{2/3} = 0.26 \left(1 - \frac{x}{x_0} \right),$$

where $x = Z^2/A$, and x_0 is the value of x for which E_f vanishes.

$$x_0 = \left(\frac{16\pi S r_0^3}{e^2} \right)$$

Nuclei with Z^2/A exceeding x_0 cannot exist in nature. They would undergo spontaneous fission.

From the variation of binding energy with mass number, the value of S can be easily estimated. It is found that $4\pi r_0^2 S = 14(MV)$ or $S \sim 0.91 \times 10^{20}$ dynes/cm. and this gives $x_0 = 54$, a value nearly 50 per cent. larger than (Z^2/A) for uranium. Though no reliance can be placed on the above equation for E_f for predicting its value for different nuclei, it serves to illustrate its broad dependence on Z^2/A , e.g., why E_f for U_{235} is smaller than for U_{238} . As already mentioned, the problem of fission has been examined in considerable detail by Bohr and Wheeler who using the observed value of E_f for U_{239} have estimated it for other heavy nuclei of interest. These are exhibited in Fig. 2. (Plutonium and Neptunium have been added.).

The liquid-drop model* of a nucleus affords insight into the phenomenon of fission and also serves to explain many of

a typical heavy nucleus is appreciably larger than the threshold values for (ii) and (iii), the probability for photon emission is small compared to that for (ii) and (iii); and again that for neutron emission is generally larger than that leading to fission, and it becomes still larger with increasing energy of excitation.

It has been mentioned before that the critical deformation energy E_f for fission increases with (Z^2/A) . For (Z^2/A) less than about 35, E_f becomes so large that when the excitation energy exceeds this value the probability of fission is negligibly small compared to the probability of neutron and photon emission. It is only for the very heaviest nuclei that fission is practically realizable.

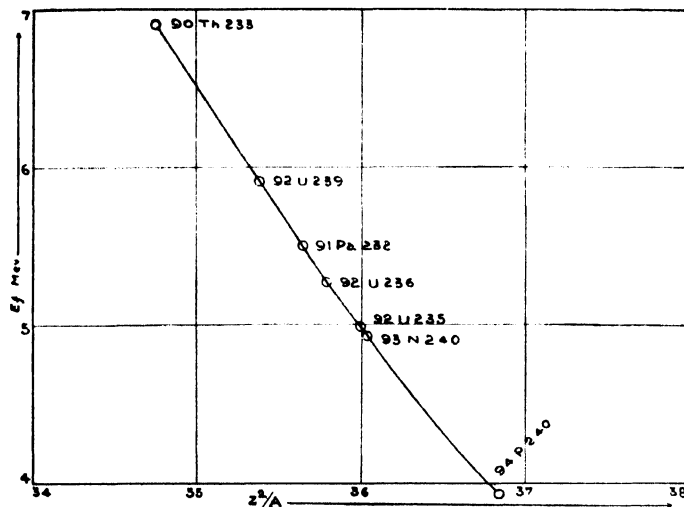


Fig. 2.

the characteristic properties of nuclei. The formalism of statistical thermodynamics can be applied to discuss the behaviour of nucleons in a nucleus,† e.g., the density of energy levels of the nucleus evaluated in terms of its entropy, the density-fluctuations correlated with meson-scattering, and so on. Illuminating as this study is, we shall not go into it here.

Reverting again to fission, it is necessary to remember that when a nucleus is imparted energy exceeding E_f , fission is not the inevitable result. A nucleus can get rid of its excitation energy in many different ways which can be regarded as proceeding independently and in mutual competition with each other. It may emit an electron, a positron, a photon, a neutron, a proton, an alpha-particle, or undergo fission. The probability of electron or positron emission is relatively small, and again for heavy nuclei, on account of the high potential barrier, the leakage of a proton or an alpha-particle is very improbable; the competitors that really matter for the excitation energy are (i) photon emission, (ii) neutron emission and (iii) fission. When the energy of excitation for

Nuclear excitation can be brought about in many different ways, e.g., by absorption of a photon, capture of a proton, neutron or alpha-particle. The probability of a few million electron-volt excitation by radiation is, in general, very small. Again, on account of the potential barrier, the probability for a charged particle to penetrate into the nucleus is inappreciable unless the velocity of the impinging particle is sufficiently high. However, most of the charged particles when they strike the target, will, in general, be slowed down on account of collisions with the extra-nuclear electrons, and, say, only one in a million or so will retain enough energy to penetrate the nucleus. When a particle does succeed in entering a nucleus, the energy released is of the order of a million electron-volts. However, the energy spent in accelerating the large number of charged particles that never succeed in entering the nuclei, but waste their energy on the extra nuclear electrons, is so large that even under the best conditions, the use of charged projectiles as a means of releasing subatomic energy is not profitable.* With neutrons the situation is different. A neutron being uncharged has no potential barrier to

* The "liquid" may perhaps be conceived as a type of superfluid recently envisaged by Landau in connection with the theory of liquid helium II.

† See, for instance, Bethe, *Reviews of Modern Physics*, 1937, 9.

* The loss of energy may also be pictured as a degradation of "temperature." The incident particles, on account of their high kinetic energy, have a "temperature" comparable to 10^{10} degrees. When

overcome and it can, therefore, penetrate the nucleus, no matter what its velocity may be. In the region of neutron energies of the order of 0.1 electron-volt, the cross section for capture, in general, varies *inversely* as the neutron velocity—the slower a neutron, the greater the chance of its absorption by a nucleus. The neutrons thus provide the most effective and fruitful means for releasing subatomic energy.

The capture by a heavy nucleus of a slow neutron (i.e., a neutron with negligible kinetic energy), excites it to a state of energy of about 6 *MeV*. We shall denote by E_0 the excitation energy of the compound nucleus formed by the capture of a *slow* neutron, e.g., for U_{236} (which is formed on neutron-capture by U_{235}) the excitation energy E_0 is slightly greater than 6 *MeV*, whereas for U_{239} (formed on neutron-capture by U_{238}) E_0 is very nearly 5 *MeV*. Referring to Fig. 1, it will be noticed that for U_{236} , E_0 exceeds by about 1 *MeV* the critical deformation energy (E_f) leading to fission, whereas opposite is the case for U_{239} . For the phenomena of fission this difference in the properties of U_{236} and U_{239} is of extreme importance. The capture of slow neutrons by U_{238} will not result in fission, but in the case of U_{235} fission is possible. For brevity of description nuclei for which E_0 is *less* than E_f will be referred to as A-nuclei, and nuclei with E_0 *greater* than E_f will be called B-nuclei. In nuclei of type-B, fission will result even when slow neutrons are captured, but for type-A fission will be possible only with neutrons of kinetic energy exceeding ($E_f - E_0$).

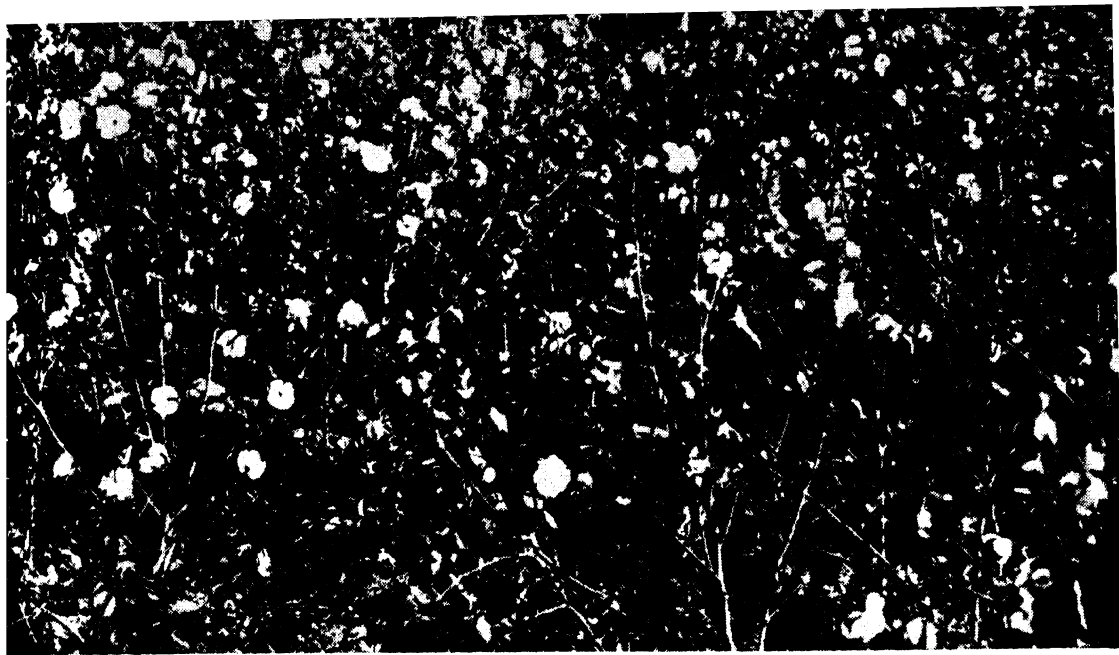
When a heavy nucleus captures a (slow) neutron the excitation energy as mentioned above is about 6 *MeV*. On account of the addition of this energy to the nucleus the nuclear temperature (T), as can be shown by a simple application of statistical thermodynamics to nuclei, jumps from zero to about 0.6 *MeV* in energy units, that is to about 0.7×10^{10} degrees. The average energy of

they enter the cold target (at room temperature), the effect of collisions between the incident particles and the electrons and nuclei in the target is to lower the temperature (i.e., to reduce the velocity) of the incident particles and ultimately reduce it to the target temperature. In thermo-nuclear reactions occurring in stellar interiors, the situation is different. All particles (electrons, protons, etc.) are at the same temperature and there is no question of slowing down of particles on account of mutual collisions.

neutrons or photons emitted from excited nuclei will be comparable to KT , and, therefore, the average energy of neutrons emitted from excited (heavy) nuclei is roughly of the order of a million electron-volts.

We are now prepared to examine, in general terms, the conditions for generating a self-maintained chain-reaction in an assemblage of nuclei—it is only a self-sustained chain-reaction which can make available nuclear energy fruitfully larger than the energy which will be spent in initiating the reaction. It has already been mentioned that neutrons alone provide a profitable means of releasing nuclear energy. Further, as neutrons are emitted during the fission of uranium—this was demonstrated by Halban, Joliot and Kowarski, and Anderson, Fermi and Hanstein, and others—the possibility of initiating a chain of fissions in a mass of uranium appears practicable. It is obvious that the very first requirement to initiate a chain of fissions in an assembly of nuclei is that the neutrons generated during fission are not allowed, at any rate not all of them, to escape from the assembly. There are two ways in which this can be achieved, (i) the size of the assembly is large compared to the mean free path (λ) of neutrons in the assembly or (ii) the assembly is enclosed by a material which will not appreciably absorb the neutrons but return them to the assembly. Both methods have been utilized, the first in the atomic bomb itself and the second in what is called a “moderator.” Heavy hydrogen or heavy water, helium, beryllium and carbon are suitable for use in the moderator. If a chain of fissions, when once started in the assembly of nuclei, is not to perish before almost all the (fissionable) nuclei have undergone fission, it is not enough merely to ensure that neutrons do not leak out from the assembly. An additional condition, which is concerned with the probability of fission in comparison to the probabilities of other competing processes (neutron and photon emission) has to be realized.* The problem of chain-reaction will be discussed in the next section of this article.

*The practical realization of a self-maintained chain-reaction depends on the use of U_{235} and plutonium ($Z=94$; $A=239$). It may perhaps be mentioned that in a thermodynamically ideal process, the work required for effecting separation of the uranium isotopes would be fantastically small compared to the tremendously large expenditure of energy actually spent in isolating U_{235} .



SYNTHETIC FIBRES IN RELATION TO THEIR COMPETITIVENESS WITH COTTON

By NAZIR AHMAD

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DURING the past few years many synthetic fibres have been developed, and these have found numerous outlets in industry. Some have been used largely in the manufacture of clothing materials, others for hosiery, still others have found special use in upholstery, tapestries, millinery trades, while certain synthetic fibres have been developed for special purposes such as girdles, handbags, carpets, airmen's jackets, motor car tyres, window screens, etc. The oldest and the most important among them is rayon, while the others, listed below, are as yet in their infancy. Judging from the rapid developments which have already been made and the amount of research work which is devoted to them, it is safe to assume that we will see considerable expansion in their use in the near future. These man-made fibres have one common advantage over the natural fibres like cotton in so far as their fineness and, in many cases, staple length can be readily changed at will, while their other physical properties, such as strength, water permeability, rot-proofness, etc., can also be modified to a considerable extent. Each one of them

possesses certain special characteristics and limitations, and the object of this brief note is to consider the probable impact of their development on natural fibres, with special reference to cotton. The synthetic fibres considered are :—

Nylon.
Rayon, Fortisan.
Vinyon, Vinyon E and Saran.
Protein fibres—Aralac, Ardil.
Plexon.
Glass fibre.

Nylon

This trade name covers a group of chemical compounds (polyamides) which may be made into sheets, bristles, moulded plastics, coating material for fabrics and wires and textile fibres. It was developed originally in the research laboratories of *Du Pont* in U.S.A., who have entered into arrangements with large manufacturers in other countries, including the *Imperial Chemical Industries*, for the exploitation of its patent rights. Research work by a large staff has been continually carried out on it, and at present there are at least 10 nylons, suited for different purposes, which have reached

the stage of commercial production. Its production has increased rapidly since it was first put on the market, rising from 4 million lbs. in 1939 to 25 million lbs. in 1944. It is also known that considerable further expansion is planned for the post-war period. Among the nylons which have been recently developed, there are two which deserve special mention. One is a practically fireproof material which can stand upto a temperature of 400° F. It should be specially useful in making firemen's garments, anti-incendiary fabrics and for insulation purposes. The other is as elastic as rubber and should be specially attractive for making belts, suspenders, etc. As regards the ordinary nylon fibre, there would not appear to be very great likelihood of long-staple cotton suffering from a severe competition from it in the near future, though with the continual advances being made in its properties and utilization, it is difficult to foresee what might happen in twenty or thirty years' time. This conclusion is based primarily upon two considerations, (1) the disparity between the price of nylon and cotton and (2) the physical properties possessed by nylon as distinct from those characterising cotton. As regards the first point, the present disparity between the price of nylon and cotton is very large, being in the ratio of about 6 to 1, with the result that whereas cotton fabrics are within the reach of the masses, nylon fabrics may be bought only by well-to-do classes, or used for special purposes, such as military requirements. When it was first marketed in 1940, its price ranged from \$4.27 to \$4.55 per lb. in yarn sizes suitable for hosiery, but since then its price has been reduced, and in 1944 certain sizes suitable for special military purposes (but not suitable for hosiery) ranged in price from \$1.62 to \$2.65 per lb. It is possible, even probable, that with technological advance and mass production, the price of the material suitable for clothing materials may come down in the future, but even so, it is regarded as unlikely that it will fall to the level of the price of long-stapled cotton owing to the high cost of chemicals (benzene or phenol, ammonia, etc.) required in its manufacture. In this connection it should be noted that determined efforts are being made in the U.S.A. to bring down the cost of cultivation of cotton by improved farming, mechanical picking, etc., and there is evidence to

show that large quantities of cotton would be produced in the U.S.A. at costs considerably lower than those which have prevailed in the past. The opinion has been expressed authoritatively that it might be possible, in normal times, to stabilize the price of ginned cotton at about 12 cents per lb. Thus, the effect of a decline in the price of nylon due to technological advance and increased production might be neutralized, to some extent, at least, by a reduction in the price of raw cotton.

As regards the second factor, namely, the physical characteristics of nylon, it is true that it possesses many excellent properties such as high tensile strength (from 4.5 to 7.0 gms. per denier), high elasticity (superior to all fibres in this respect), high wet strength (90 per cent. of the dry strength), ability to take a permanent set or shape when heated with hot water or saturated steam, resistance to alkalis, mildew, marine and soil micro-organisms, etc., which give it a greater start. But, on the other hand, it possesses certain properties which place it at a disadvantage as compared with cotton. It absorbs very little moisture, which might be a point in favour of its use in the manufacture of raincoats, but is clearly a disadvantage in the manufacture of numerous kinds of fabrics, especially those which are worn next to the skin. As such, the nylon fabrics feel clammy, and become slippery on account of unabsorbed perspiration. Again, it becomes easily charged with static electricity, which makes it very suitable for insulation materials, but rather unfit for certain other kinds of fabrics. It is, of course, possible that these defects may be eliminated in course of time, but we are concerned in this comparison with the material as it is offered at present.

Before the war, nylon was used mostly for women's hosiery and to a lesser extent for neckties, fishlines, thread, foundation garments, knitted underwear, etc. During the war it has been used largely for parachutes, raincoats, mosquito curtains (for rainy areas), tow-lines, tyre cords, etc. In many of its uses it has replaced and will replace natural silk, where the price is about the same, though in some of its uses (mosquito curtain, tyre cords, etc.) it has also affected cotton to some extent. But, taking both the factors mentioned above into account, it is fairly certain that although the production of nylon will increase in the

future and although it is probable that its price will come down, yet it is unlikely, in the near future, to make deep inroads into many of the uses to which cotton is put at present.

Rayon, Fortisan

The position, however, is quite different with rayon. Its expansion since 1920 has been truly phenomenal, its output increasing from about 33 million lbs. in 1920 to 3,473 million lbs. in 1942, of which the U.S.A. alone contributed about 650 million lbs. One of the outstanding reasons for this rapid increase has been the development of the rayon staple fibre, which, in a pure or blended state, can be spun upon cotton machinery with a few minor modifications. In 1942 the world production of staple fibre was reported to be 2,026 million lbs. of which the U.S.A. contributed about 150 million lbs. The rayon manufacturers in the U.S.A. are planning to increase the production of rayon by 100 per cent. in the next few years, and it is highly probable that a similar expansion will take place in Great Britain and in some of the European countries.

The price factor has been greatly in favour of rayon. Since its manufacture on a large scale after the first World War, its price has been continually brought down as a result of technological advance and increased production. Thus, from 1920 to 1943, the average price of rayon yarn in the U.S.A. declined from \$4.5 to \$0.55, the latter price being the same as that of cotton yarn of similar quality. It is noteworthy, in this connection, that, despite the general rise in price level in the U.S.A., the price of rayon has either remained at the pre-war (World War II) level or has even declined slightly, and there are indications to show that it might be possible to effect further reductions in price in the future. Thus, it can compete very strongly in respect of price with long-staple or even medium-staple cotton.

Apart from the price factor, the numerous uses to which rayon has been put either in the pure or blended state, are those for which cotton was commonly used in the pre-rayon days. These are wearing apparel (woven goods) of many types, tablecloths, napkins, draperies, upholstering fabrics, blankets, tyre fabrics, etc. The ability of viscose rayon (which constitutes the bulk of rayon production) to take cotton dyes

is another point in its favour; while, after blending it with wool, linen, etc., very attractive effects can be produced by cross dyeing. The research staff in the laboratories of the rayon companies in the U.S.A. has been busy in experimenting upon new designs and patterns made from rayon, pure as well as blended with other fibres, and has worked out the details of these new fabrics. It is proposed to put them into large-scale production as soon as possible and in view of their attractiveness and low price, it is certain that they will constitute serious rivals to many types of cotton fabrics.

It is true that as against its attractive appearance, cheap price and wide range of utility, rayon possesses several disadvantages as compared with cotton, which have imposed certain limitations on its use in the past. Chief among these are its low wet strength (about 50 per cent. of the dry strength), poor durability, liability to permanent distortion through stretching, susceptibility to tendering in laundering, low resilience, etc. As a result of these drawbacks its use has been somewhat restricted in many directions, especially where appearance is not the primary consideration, and durability has to be combined with cheapness, such as bags, work clothing, men's and boys' underwear, sheets and pillow cases, business and dress shirts, towels, wool suitings, cordage and twine, etc. It should, however, be noted, in this connection, that during the last few years, great improvements have been made in the physical properties of rayon, and it is anticipated that further improvements will be made as a result of scientific research. Thus, the average dry tensile strength of 150 denier viscose yarns has improved from 1.6 gms. in 1925 to 2.2 gms. at the present time, while the emergence of the so-called high tenacity viscose yarns during the war has opened up a new group of uses such as parachutes, tyre cords for aeroplanes, buses and heavy duty trucks, etc.

Mention may be made here of some of the new types of rayon which have been developed during the past few years. One of them, perfected in the laboratories of *Messrs. Du Pont & Co.*, is specially suited for carpets. Another one, developed by the *American Viscose Corporation*, is a comparatively short-staple fibre but it is extremely fine, and is specially suited for the manu-

facture of very strong light-weight fabrics. These rayons are of the viscose type, but the acetate companies have also not been idle. The *Celanese Corporation* have produced a new type of fibre called Fortisan, which is a modified type of cellulose acetate and which is likely to offer competition to nylon. It is said to be even stronger than nylon, but does not possess the same resilience. It is especially suitable for girdles and other garments in which lightness of weight should be combined with tensile strength and durability.

In view of these developments, it is almost certain that rayon will be in a strong position to offer powerful competition to cotton in the future, and even though it might not be able to displace cotton from some of its present-day uses, it would impose severe restrictions upon its use in other fields, thereby neutralizing, to some extent at least, the advantages that may be expected to accrue from normal increase in population and general rise in the standard of living. This forecast is supported by the trend prevailing in the past, which shows that whereas the ratio of cotton to the total fibre consumed in the U.S.A. declined from 87 per cent. to 80 per cent. between 1925 and 1942, that of rayon increased from 0.3 per cent. to 10.3 per cent. in the same period. Corresponding figures for the world production bring out this feature even more strikingly. The total world production of rayon in 1942 was equivalent to $8\frac{1}{2}$ million bales of cotton, which represents some 27 per cent. of the average consumption of cotton for the period 1935-39.

Vinyon, Vinyon E and Saran

These fibres are made from synthetic resins, and while possessing certain common features, have each certain distinctive properties. They are all thermo-plastic and offer very good resistance to water, acids and alkalies. Since vinyon shrinks at 150° F., it cannot be used for garments which are ironed, but it has been used with considerable success for making filter cloths, fish nets and fishlines, gloves, upholstery, millinery cloth and tyre cord. It is now sold from \$1.40 to \$1.80 per lb. in continuous filament form. An improved type of vinyon, made from petroleum sources, has recently been placed on the market by the *Union Carbide and Carbon Corporation of America*, which is said to be as good as

nylon and which is specially suited for hosiery. It is tough but elastic and is quite soft to touch. Vinyon E, while possessing the other properties of vinyon, has a very high extensibility (150 to 300 per cent.) which makes it especially useful as a substitute for rubber in elastic tapes and suspension cords. Saran, developed by the *Dow Chemical Corporation*, is superior to vinyon in its resistance to rupture from flexing, impermeability to water and ability to withstand high temperatures (240° to 280° F.) before shrinking. It has been used principally for window screening, plumbing pipes, upholstering of trains, buses and cars and cordage, and its present production is estimated to be about one million lbs. per annum.

In view of the special properties possessed mentioned above, it is doubtful if these fibres will replace cotton to any appreciable extent in the near future. On the other hand, it is quite possible they might open up new uses for cotton in union fabrics.

Protein Fibres—Aralac, Ardil

These are derived from proteins of animal (milk casein) or vegetable (soya-beans, corn, peanuts, etc.) origin, and, like the synthetic resin fibres, are as yet in their initial stages of development. The fibre made from milk casein in the U.S.A. is known as Aralac; it is sold at about 64 cents per lb., and its present production is estimated at 8 million lbs. per annum. In its appearance, susceptibility to alkalies, crimp warmth qualities, reaction to dyes and moisture absorption, it closely resembles wool, but is inferior to it in elasticity, crease-resistance and clinging power. So far it has been used largely in dress fabrics, suitings, scarfs, neckties, etc., but fabrics made entirely of aralac are not regarded as very satisfactory owing to their poor wearing quality. The soya-bean fibre, which alone of the vegetable protein fibres, has made any headway and is planned to sell at about 65 cents per lb. also resembles wool in its dyeing properties, resiliency and heat insulation, but its wet strength is so low that, in its present form, it is extremely doubtful if it can be used on a large scale for commercial purposes. A fibre belonging to this class, called Ardil, has recently been developed by the *Imperial Chemical Industries*, and it can be easily blended with cotton. It also resembles wool in its appearance and general physical

properties, and is likely to be used as a substitute for wool in certain types of fabrics. Even after these fibres, which are as yet in their infancy, reach a high degree of perfection and shed off their present deficiencies, they are likely to offer much more competition to wool than to cotton owing to their special properties, while it is even possible that they might help cotton in finding new uses for it in union fabrics.

Plexon

This fibre is of a somewhat different type from those which have been described above. It has been developed by *Messrs. Freydburg Bros.-Straus* of U.S.A., and is prepared by treating natural fibres like cotton and flax or synthetic fibres like rayon with plastic substances which deposit a fine coating upon them. It is as yet in the initial stages of development, and has been tried for window screens, upholstery, millinery and handbags, but it is probable that its use will also extend to certain articles of hosiery. It is more in the nature of an ally rather than a rival of the natural fibres.

Glass Fibre

The development of spun glass for the manufacture of fabrics and insulation materials has made considerable progress during the last few years. It is now available in extremely fine deniers both in continuous filament as well as cut staple forms. Besides possessing a very high tensile strength, it has many distinctive properties which are not shared by many of the textile fibres. The fabrics made from it are immune to damage from ordinary acids, alkalies and micro-organisms causing mildew, they can withstand high temperatures and can be readily washed clean. The dyes can be built in the fibres themselves, and the fabrics made from them are completely fast to light, perspiration, washing, etc. As against these advantages, the glass fabrics suffer from the disadvantages of possessing very low extensibility (1 to 2 per cent.), brittleness, roughness to feel, and are apt to break at creases or with frequent bending. Owing to these limitations, its use for clothing material, especially of everyday use, is likely to remain extremely restricted, but it is eminently suited for insulation tapes, fireproof fabrics, lampshades, curtains, strengthening base for boards, etc. It is, therefore, not likely to offer very serious competition to cotton in the near future.

Conclusions

It will be seen from the above survey, that enormous advance has been made in other countries in the development of synthetic fibres which are likely to offer severe competition to the natural fibres. These great strides have been made as a result of scientific research which has been carried out principally in the laboratories of the industrial organizations. Since India is a large producer and consumer of textile goods and also stands on the threshold of industrial development in many fields, she cannot afford to remain idle while these epoch-making advances are being made elsewhere. She must embark upon a bold programme of industrial research applied to synthetic fibres which have come to stay permanently, and for this purpose she must establish properly equipped and adequately staffed laboratories in which research and development work on synthetic fibres can be carried out on a suitable scale. The Governments and industrialists in other countries are spending annually millions of pounds and hundreds of millions of dollars on these researches, and we cannot hope to compete with them and protect our rightful interests unless we are prepared to spend equivalent amounts. At the same time, since India is a large producer of natural fibres like cotton and jute on which the prosperity and welfare of a vast number of cultivators depend, it is essential that our research expenditure and programme should be so orientated that the history of indigo is not repeated on a ghastly scale and the interests of our natural fibres and their growers are properly safeguarded. So far as cotton is concerned, this can be achieved by spending adequate sums of money on cotton research and by taking vigorous and effective steps on the following lines :—

(1) To intensify research on all phases of cotton, especially with a view to achieving the following objectives :—

- (a) Development of improved varieties possessing high yield per acre, high ginning percentage and good fibre properties and spinning performance.
- (b) Reduction in the cost of cultivation per acre by the application of improved farming methods and elimination of uneconomic holdings.

- (c) Better utilization of cotton seed and its products, e.g., linters, oils and fats, proteins, etc.
- (d) Better ginning, baling and storage of cotton.
- (e) Rationalization of manufacturing processes leading towards lower costs of manufacture and elimination of obsolete machinery.
- (f) Better finishes to cotton textiles with a view to improving their strength, durability, appearance, range, etc.
- (g) Modification of the properties of the fibre with a view to imparting new qualities to it.
- (h) Better grading of the raw material, standardization of the finished goods and better marketing of both.

(2) Balanced equilibrium between the production and consumption of cotton, especially in regard to the types required for different uses, so as to avoid the depressing effects of the so-called "orphan cottons" on the market.

(3) Stabilization of agricultural prices.

(4) Scientific study of trends in the consumption markets with a view to adjusting range and volume of production to actual requirements.

(5) Keeping a close watch on the development of new synthetic fibres which are likely to compete with cotton and a systematic study of their trends in production, prices and consumption.

All these items, if properly studied, need money to provide for laboratories, staff, equipment and running expenses. Committees of practical men can very usefully indicate and guide research along broad lines and check up the results against their practical experience, but they cannot take the place of research workers nor go into those details which are necessary for the formation of sound conclusions. If the expenditure is forthcoming on a scale which is compatible with the magnitude of the problems, the size of the crop, the numbers of people whose livelihood and welfare depends upon the production, marketing and manufacture of cotton, the share of cotton in the economy of the country as a whole, it is almost certain that cotton, possessing many natural advantages and the force of traditional use, will be able to hold its own against the synthetic fibres, while the development of the latter, strengthened by scientific research, will proceed along harmonious lines adjusted to the requirements and economy of the country.

NOBEL PRIZE AWARDS

PROFESSOR Wolfgang Pauli (Switzerland) has been awarded the Nobel Prize for *Physics* for the year 1944. Professor Pauli, who is at present in Princeton University in the United States of America, is the discoverer of the "Pauli Principle" which has led to the elucidation of the periodic classification and the interpretation of the spectra of elements.

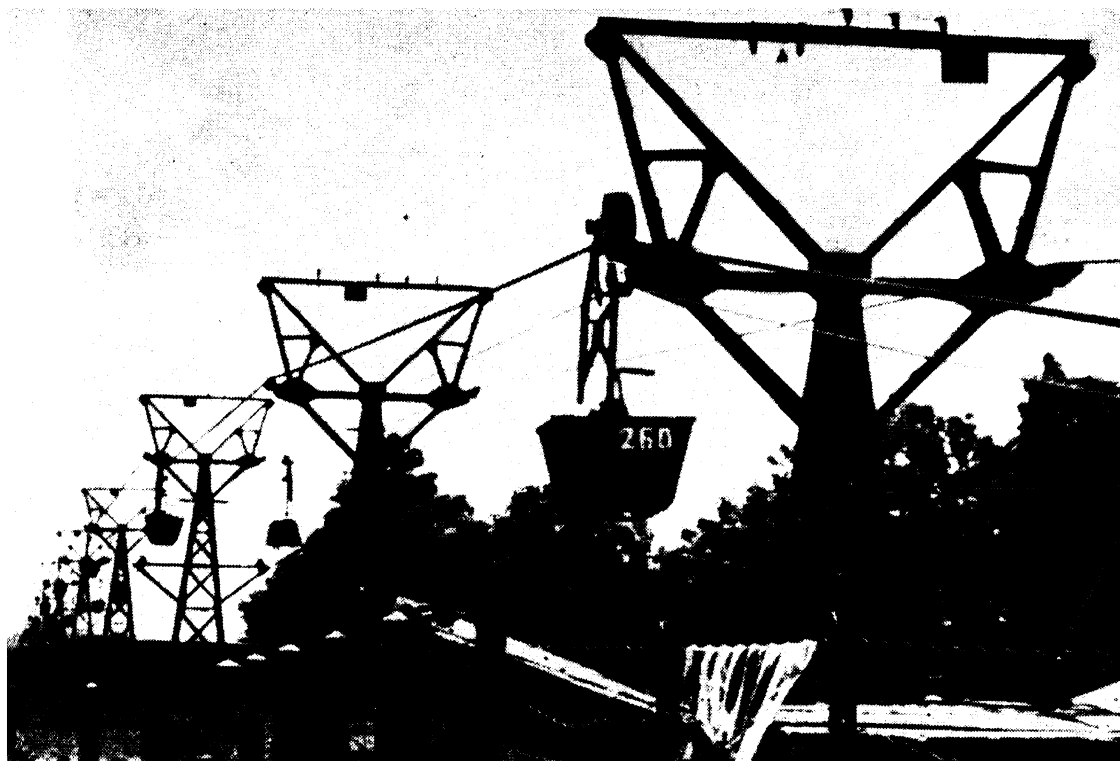
The 1944 Award for *Chemistry* has been made to Professor **Otto-Hahn**, the German radiologist. Prof. Otto-Hahn is now reported to be in the U.S.A.

The 1945 prize for *Chemistry* has been won by Professor **Arturi I. Virtanen**, of the Biochemical Institute, Helsinki (Finland). Prof. Virtanen is best known for his researches on the nitrogen metabolism of the

micro-organisms of root-nodules. The red pigment of the legume root nodules has been identified as a hæmoglobin as a result of his recent researches.

The 1945 Prize for *Medicine* has been awarded jointly to Sir **Alexander Fleming**, Sir **Howard Florey** and Dr. **E. B. Chain**, who have successfully collaborated in the study of the production, therapeutic use and mode of action of penicillin. Their investigations have given mankind the "wonder drug" penicillin, and opened a new chapter in the history of the fight against disease.

The **International Red Cross**, Geneva, has been awarded the *Peace Prize* for 1944, while Mr. **Cordell Hull** wins the *Peace Prize* for 1945.



COAL IN INDIA *

By S. K. ROY

(Indian School of Mines, Dhanbad)

(Continued from October issue)

NOW comes the question, did the accumulation of the mother substance of the coal seams result from vegetation which grew on the spot, where the seams are now found, or did it consist of debris drifted from a distance? There are two theories regarding the formation of coal seams, known respectively as the *in-situ* and *drift* theories. Geologists who advocate the first-named theory maintain that coal beds are the remains of plants, etc., which flourished long ago on the exact site now occupied by the coal itself. It is assumed that the vegetation at that period was of a most luxuriant character, covering immense tracts of flat, marshy ground lying almost at water level. Plant life flourished and died in rapid succession, aided no doubt by a warm, moist atmosphere. In the course of time the low lying land, a geosyncline, covered by a more or less thick bed and

decaying vegetable matter, became covered with water due to rather quick movements of the earth's surface and formed a large inland basin or lagoon. Mud and sand carried in suspension in the water gradually settled down and covered the vegetation lying at the bottom. In time when diastrophism was slow the sea or lagoon became silted up with beds of sand and mud, thus forming a fresh surface for the growth of another plant life. In this manner layer upon layer of vegetable matter was formed, separated by layers of mud and sand. These layers were gradually changed into beds of coal, shale, and sandstone. This theory is generally accepted when the "underclay" of a seam contains fossil remains of roots, bark, etc. but seams are found, the "underclay" of which contains no such remains, and is not, strictly speaking, a clay at all. In such cases the "drift" theory is put forward.

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor, 20, Pusa Road, New Delhi.

It is argued that the vegetation in the swamps and marshes lying close to the banks of rivers was carried down by the current and deposited at the river mouth where, in the course of time, it would accumulate into huge masses and eventually sink beneath the water and become covered with sand and mud.

In both theories it is agreed that the vegetable matter was gradually covered by beds of mud and sand. This covering would protect the vegetation from the air, besides subjecting it to the action of heat and pressure. The combined action of time, heat and pressure would gradually produce a change in its physical appearance and chemical composition, and slowly convert it into some variety of coal. If some coals have originated from drifted materials, then no doubt the mother substance was deposited under estuarine conditions. If other coals have been formed from a mass of vegetable material, which once flourished where we now find a coal seam, then such coals may have originated under terrestrial conditions like peat, or under swamp conditions like those prevailing to-day in the Great Dismal Swamp of North America, or under lacustrine conditions. Both the "drift" and the "growth-in-place" theories have been strongly urged in the past, each with a view to show that the alternative, is under any circumstances, untenable.

Characteristics of coal seam of drift origin.—1. The plant impressions on a slab of shale from the roof of a coal seam, are both fragmentary and very mixed. Badly preserved impressions of plants commonly occur in the sandstones and shales associated with coal seams.

2. The stratified nature of coal leads us to believe that it must have been derived from drifted materials.

3. Splitting of the coal seams is supposed to be due to drifting of plants. Splitting is also explained by local unconformity.

4. Presence of rolls or swells in the seams are said to be signs of current action.

5. Pebbles in coal and also coal balls are supposed to be due to drifting, but the "ball structure" in coal has been definitely proved to be due to peculiar jointing of coal (Bhola and Majeed—*Q. J. Geol. Min. Met. Soc.*, 1931, 3, 13).

Characteristics of coal seams formed in situ.—1. The first characteristic is the purity of coal seams. This is one of the most remarkable features of many seams of coal. By purity is implied the general absence of any sand or mud inter-mixed with the coal. If we contrast a coal seam with the rocks occurring associated with it in this respect, the relative purity of the seam is thrown very much into prominence. The associated sandstones and shales are frequently impure and vary in composition more abruptly than is the case in coal. The sandstones pass laterally, as we often see, into argillaceous rocks, with all gradations between them. The shales also become frequently sandy, and may merge into arenaceous rocks. But a seam of coal consists overwhelmingly of hydrocarbons pure and simple, and it is rare to find arenaceous or argillaceous impurities mixed with the coal, or coal seams passing into such rocks.

The purity of coal seams of the Gondwana fields has always been one of the great arguments in favour of the *in-situ* theory, and rightly so. The Dishergarh, Ponihati and many other seams of the Raniganj coalfield as well as the 17th seam, 18th seam, 14th seam and many other seams of the Jharia coalfield are remarkable for their purity of quality throughout the fields. On the drift hypothesis, it is difficult to explain why, if the original mother substance had been swept along for considerable distances in rivers, it did not become intimately mixed with earthy particles, such as mud or sand, etc., at least in variable quantities.

2. The uniformity of the thickness of seams and the composition of coal seams have been urged as other general arguments in favour of the *in situ* theory. Uniformity of thickness and composition is remarkable with many of the coal seams of the Giridih, Jharia and Raniganj coalfields.

3. There are beds of hard clay on which a coal seam almost always rests. They are called *underclays*. Unstratified clay deposits may occur immediately below coal seams. The origin of these clays as being old soils is no doubt a chief prop of the *in-situ* theory. These clays are full of the rhizospores of *Lepidodendron*, *Sigillaria* and roots of *Glossopteris* (*Vertebraria*) and other Palæozoic plants. Such

underclay beds with vertebraria have been found in the Gondwana coalfields.

4. Upright trunks occur in the underclays and also in the sandstones and other rocks associated with the coal. In some cases the trunks are so numerous as to suggest that we are dealing with a fossil tree forest. The occurrence of upright trunks or stumps of trees in the Coal Measures has been regarded as good evidence of growth-*in-situ* theory. Upright trunks have, however, not yet been discovered in India.

5. Presence of leaves and twigs in the roof of the seam is another evidence in support of the *in-situ* theory. This is a very common feature of many coal seams in India.

6. Against the suggestion that stratified appearance of coal is a sign of the drift origin of the mineral, it may be noted that this stratified appearance of coal is often due to the heterogeneous nature of the vegetation forming the original substance. From our present-day experience of the Great Dismal Swamp we know that the *in-situ* origin of coal is not only possible but most probable. The Karharbari coal and certain sections of the coal of Salanpur "A" seam are not stratified at all.

From the above and from the nature of the associated rocks, the *in-situ* fluviolacustrine theory seems to be more plausible in case of the origin of the Gondwana coal seams of our country. But the lenticular nature of the Tertiary coal seams and their occasional association with massive numulitic beds and other marine formations possibly suggest that they are estuarine deposits and most probably of drift origin.

The Lower Gondwana Coalfields of India⁵

A.—COALFIELDS OF BIHAR

I.—Coalfields of the Rajmahal Area.

(1) *Hura and Jilbari Coalfields*.—A 9-foot seam has been reported under the hill of Dakaita near the village of Phulbera. Two seams the upper one about 6 ft. thick, occur near Jilbari.

(2) *Chuparbhitia Coalfield*.—This coalfield is about 7 miles long. Near Malikbathan two coal seams, 9 feet and 6 feet in thickness, have been reported, but the coal is of poor quality.

(3) *Pachwara Coalfield*.—Long flaming non-caking coal of high moisture has been

reported from this coalfield and it is worked near Bargo and Chilgo. It is locally used for brick burning.

(4) *Brahmani Coalfield*.—The promising area extends from Panchbahini to Saldaha, west and north-west of Sarsabad.

It is estimated that the total area of the above coalfields is about 70 square miles. The reserve is estimated at about 200 million tons. Two coal seams of Hura coalfields seem to be promising.

II.—Deoghar Coalfields.

(1) *Kundit Karaia Coalfield*.—This coalfield has two thin coal seams occurring near village Khairbani.

(2) *Sahajuri Coalfield*.—There are two coal seams 18'-25' in thickness, which are worked at various places. The reserves are estimated to be about 22 million tons but the coal is inferior.

(3) *Jainti Coalfield*.—This coalfield has three seams of good quality coal of which the lower seam of 4'-4" in thickness is of very good quality possessing calorific value of 7,215 calories. The reserve is about 2 million tons of good quality coal, of which 1 million tons is coking.

III.—Hazaribagh Coalfields.

(1) *Giridih or Karharbari Coalfield*.—The area of this field is about 11 square miles of which 7 sq. miles are promising. The field contains three seams—called Karharbari Lower and Upper seams and Hill seam. The Upper Karharbari seam which is from 4 to 10 feet in thickness is practically exhausted. The Lower Karharbari seam is 15 to 24 feet in thickness. The coal of this seam is the finest caking coal, necessary for our metallurgical industry, available in India, but this coal is now being solely utilized in firing the railway engines. Fuel research and the establishment of a Fuel Research Station in India are meaningless until such coals are conserved as it is well known that compared with the iron ore reserves of India, the reserve of coking coal in this country is insignificant. The sulphur and ash content of the Giridih coal seams are below 0.02 per cent. The Giridih coals are dull. Similar is the appearance of the coal of Salanpur "A" seam in Raniganj coalfield. The total available coal in this field in 1934 was estimated to be 49 million

tons and the life of the coalfield to be not more than 25 years.

(2) *Chope Coalfield*.—One coal seam, 4 ft. in thickness, is known in this field.

(3) *Itkhorī Coalfield*.—Three coal seams of which the lowest is 8 ft. thick, the middle 4 ft. thick and the top of an unknown thickness have been reported from this coalfield. The quantity of coal is estimated at $1\frac{1}{2}$ million tons.

IV.—*Damodar Valley Coalfields.*

(1) *Jharia Coalfield*⁸.—This is the most important of all the coalfields of India being responsible for the production of almost half the total coal mined in India. The total area of coal-bearing rocks of Jharia coalfield is 105 sq. miles. There are 18 to 19 coal seams of workable thickness in the Barakar series of this coalfield and 9 to 10 seams in the Raniganj series. The coal seams of the Barakar series have been numbered serially, the bottom seam as I and the top seam as XVIII. Coal found in the upper nine seams is caking coal, usually of good quality. Plant fossils—glossopteris leaves and its roots known as vertebraria as well as schizoneura stems and leaves and silicified trunks of dadoxylon trees are often found in the coal measures of the Jharia Coalfield. The calorific value of X seam is above 6,000 calories and those of higher seams are between 6,500 and 7,600 calories but usually it is round about 7,000 calories. The calorific value of the Raniganj series coals of the Jharia coalfield are between 6,000 and 7,000 calories. The total workable coal reserves of the Jharia coalfield are the following :—

Within 500 ft. from the surface	2,000 million tons.
1,000 ft.	3,500 "
2,000 ft.	4,500 "
	(approx.) "

The life of the coalfield, however, is mostly dependent on the reserves of superior grade coals occurring above seam No. IX. If the Sand Stowing Act were not introduced this reserve, at the gradually increasing rate of consumption as was in vogue in previous fifty years, was to last only about another 20 years, but with sand packing the life of the field can now be expected to be another 40 to 50 years.

As the upper seams of the Jharia coalfield (X seam and above) contain an enormous quantity of excellent coking coal, the Jharia coalfield has been rightly called

"the most important store house for the metallurgical coal in India." This metallurgical coal is also meeting with the same ignoble fate as the Giridih coal. Caking coal of inferior quality (high-ash caking coals) as found in the Jharia coalfield, make the finest domestic fuel (soft coke) available in India. But the soft coke is manufactured in the open and, therefore, crores of rupees worth of by-products are lost to the country.

(2) *Chandrapura Coalfield*.—This ideally basin-shaped Gondwana coalfield of only 400 acres in area occurring at the western end of the Jharia coalfield near Chandrapura Railway Station (E.I.R.) has been surveyed in great detail by Sardar B.S. Lamba and Dr. B. C. Roy. They both found out 6 to 7 elliptically out-cropping coal seams, one of more than 25 feet in thickness and another near about 10 feet in thickness, occasionally disturbed by faults. Much of the coal is of fair (II grade) quality.

(3) *Bokaro Coalfield*.—Twenty-nine coal seams were traced in this coalfield by boring. Their thicknesses vary from 4 feet to 69 feet. Some of its coal is partially caking and of very good quality having calorific value of more than 7,000 calories. Sometimes the phosphorus content is about 3.7 per cent. The Kargali seam of East Bokaro field is the most important seam; in one section it is 125 ft. thick, including thin bands of carbonaceous shale. About 1,000 million tons of coal are available here of which half is of good coking quality.

(4) *Ramgarh Coalfield*.—The coal-bearing rocks of this coalfield occupy about 30 sq. miles and in this there are three thick coal seams varying in thickness from 26 feet to 36 feet.

(5) *South Karanpura and North Karanpura Coalfields*.—Several coal seams up to 50 feet in thickness (the Argada seam being 90' thick) occur in the South Karanpura coalfield, and there are several coal seams in the North Karanpura field, some of them being more than 72 ft. thick. Calorific values of South Karanpura coals vary between 6,500 and 6,900 calories, the Argada seam topping the list. The total reserve of first and second class coals in the Karanpura fields down to 2,000 ft. depth is between 5,000 and 10,000 million tons.

(6) *Auranga Coalfield*.—This coalfield has an area of about 100 sq. miles ; there are many coal seams in this area, some of them attaining a thickness of about 40 feet.

(7) *Hutar Coalfield*.—This coalfield occurs 12 miles west of Auranga coalfield in the Palamau District of Bihar. Its area is about 80 sq. miles. Many coal seams of variable thickness have been found in the partially explored coalfield, one of them being 13'-8" thick.

(8) *Daltongunj Coalfield*.—Thirty-two square miles of this coalfield is covered by coal-bearing Barakar rocks. A coal seam of about 30 feet in thickness occurs at the Rajhara Railway Station. A boring proved the presence of 14 seams of 6 inches to 5 ft. of coal. The reserve of coal in an area of one square mile near Rajhara was estimated to be 9 million tons.

B.—COALFIELDS OF BENGAL AND BIHAR

(1) *Raniganj Coalfield*⁹.—The present known limit of this coalfield has an area of 600 sq. miles. But this coalfield does extend to a long distance beyond its eastern limits as known at present, where the coal-bearing rocks lie under a thick mantle of alluvium. Occasional borings carried out in this area by the railway and various private bodies have revealed coal but no one has so far cared to report on them in a systematic manner. Coal seams occur both in the Barakar and in the Raniganj series of the Raniganj coalfield. Following are the important coal seams of the Barakar stage :—

Salanpur "A" seam.	(Calorific value 7,150 calories.)
Laikdih seam ..	(Good coking coal ; cal. val. about 7,600 calories.)
Begunia seam ..	(Coking coal ; cal. val. about 7,200 calories.)
Ramnagar seam ..	(Coking coal, cal. val. 7,000 calories approx.)

The following are the important coal seams of the Raniganj series :—

Ponihati seam ..	(Cal. val. about 7,200 calories.)
Dishergarh seam ..	(Cal. val. about 7,200 calories.)
Jambad seam ..	(Cal. val. 6,800 calories.)
Niga seam ..	(Cal. val. 6,800 calories.)
Ghusick seam ..	(Cal. val. 6,900 calories.)

Usually coals of the following seams of the Raniganj coalfield are used for making metallurgical coke either alone or mixed with highly coking Jharia coals. The seams

are : Ramnagar, Laikdih, Begunia, Ponihati, and Dishergarh. The reserves of these seams, as are still available (a) within a depth of 1,000 feet, about 80 million tons ; (b) within a depth of 2,000 feet, about 250 million tons.

Non-coking coals of superior quality are found in the following seams of the Raniganj coalfield—Salanpur "A" seam ; Gourangdih seam ; Samla seam ; Raghunathbatty seam ; Jambad seam ; Niga seam ; Ghusick seam ; Badjna seam.

The total reserves of all coals in the Raniganj coalfield to a depth of 2,000 feet are about 9,000 million tons. The present output of the coalfield is near about 6½ million tons which makes about 30 per cent. of India's total.

Extensive seams of *fireclay* of very good quality are found in close association with the Salanpur seam. Clay ironstone bands found in the iron-stone shale measures of the Raniganj coalfield was for many years used by the Bengal Iron Company, Kulti, in their blast furnaces.

2. *Darjeeling Coalfields*.—In Darjeeling District, promising deposits of coal were reported from Tindharia and from the area between Lishu and Ramti rivers. The coal seam of Tindharia is 11' in thickness. The late Mr. P. N. Bose discovered a number of coal seams (some of excellent coking quality) in the Lishu area. The average ash contents of the Darjeeling Gondwana coals vary between 13 and 26 per cent. Reserve of coal is about 5 million tons. The writer of this note discovered several seams of graphite shale, some containing more than 40 per cent. fixed carbon, on the banks of the Diana river at Bhutan-Bengal (Jalpaigori District) Frontier west of Chamurchi fortress, north of Diana Forest Rest House.

C.—COALFIELDS OF ORISSA

(1) *Talchir Coalfield*.—The coalfield contains two workable seams in an area of about 11 square miles near Talchir. The seams are the top seam about 9 feet in thickness and bottom seam of 13 feet in thickness. The appearance of coals of this field are dull and frequently shale-like, but certain sections of these seams are of good quality ; their calorific value being between 6,000 and 7,000 calories.

(2) *Ib River or Rampur (Sambalpur) Coalfield*.—This is a part of the South

Rewah and north-eastern C.P. coalfields extending south-east into Orissa. It contains several coal seams of which the thick seams worked in the Ib River colliery and known as the Ib River (or Rampur) seam is of good quality. Its calorific value is near about 6,600 calories. The so-called Bungalow seam has a calorific value of about 6,000 calories. Reserves of the Rampur seam within an area of 20 sq. miles and up to 600' depth are estimated to be 100 million tons.

(3) *Hingir Coalfield*.—This coalfield is situated in Hingir Zamindary of Gangpur State. This yet unexplored coalfield has an area of about 40 sq. miles. Both the rocks of the Barakar and Raniganj series occur in this field. At least one coal seam of fair quality, 45 feet thick, is known in this coalfield. According to G.C. Chatterjee, the presence of a thin 2-foot coal-seam, 30-35 ft. below the surface has been recently reported from the region between Gochhapua and Katranga in the Ganjam district.

D.—SOUTH REWA COALFIELDS

(1) *Singrauli Coalfield*.—This coalfield has an area of about 500 sq. miles. It extends into the Mirzapur district of U.P. An eight feet seam occurring near Naunagar and another seam occurring near Parari seem promising; the latter is 6-feet thick.

(2) *Korar Coalfield*.—This coalfield occurring close to Umaria field has an area of 9 sq. miles. Four seams, 4 feet to eight feet thick are known. The quality of coal is good.

(3) *Umaria Coalfield*.—This coalfield has an area of only 6 sq. miles. The most interesting fact about this field is the occurrence of marine fossils above Talchirs, discovered by Mr. K. P. Sinor in 1921. The field has six coal seams four of which, according to Sinor, are workable. Their total thickness is about 25 feet. Their calorific values vary between 4,600 and 6,300 calories. The available reserves of coal in this field are estimated at 24 million tons.

(4) *Johilla River Coalfields*.—The north Johilla field has an area of $11\frac{1}{2}$ sq. miles and south Johilla field, $3\frac{1}{4}$ sq. miles. A top 17-foot and a bottom 6-foot seam within 20 ft. of each other are known in this field. The coal is of fair to good quality. The available coal reserve within a depth of 500 ft. is about 30 million tons.

(5) *Sohagpur Coalfield*.—This coalfield has an area of about 1,200 sq. miles. Nine seams, three to five feet in thickness, occur in this field. The coals of some of them are of good quality, their ash percentage being 10 to 15 per cent.

E.—COALFIELDS OF CENTRAL PROVINCES

The coalfields of Central Provinces fall into three groups—the Chhattisgarh, Satpura and Wardha Valley.

I. Chhattisgarh Coalfields.

(1) *Tatapani-Ramkola Coalfield*.—This coalfield, though politically within the Central Provinces actually occurs at the eastern extremity of the Damodar Valley within the limits of Sirguja State (E.S.A.). It consists of two separate areas—the eastern area and the western area. The whole area comprises about 800 sq. miles of which about 100 sq. miles is coal-bearing. The eastern, i.e., Tatapani section has a 3 feet seam of 5,600 calories, a 6'-2" seam of about 6,200 calories, and a 8-foot seam of about 4,200 calories. The Ramkola coalfield has a 3-foot seam of about 6,000 calories and a 17-foot seam.

(2) *Jhilimili Coalfield*.—This coalfield is situated in Sirguja State. It contains 3 to 4 seams of more than 4 feet in thickness. Some of the coal possesses the calorific value of near about 7,000 calories, and some of the coal is of coking quality. The estimated coal reserve in this field is about $3\frac{1}{2}$ million tons.

(3) *Sanhat Coalfield*.—This coalfield in Korea State has an area of about 330 sq. miles. The coalfield can be divided into three coal horizons (i) a 16-mile belt in the eastern area with four coal seams, each approximately 5 feet in thickness; (ii) Nagar area with one seam $3\frac{1}{2}$ to 10 feet in thickness; (iii) Charcha area with a 3-foot seam. Some of the No. 1 horizon coal contains only about 15 per cent. ash. In addition to the above-mentioned coal seams, many other coal seams are said to occur in this coalfield.

(4) *Jhagrakhand Coalfield*.—Area 22 sq. miles. It is situated in the extreme eastern margin of the Sohagpur Coalfield of Rewa State; but it has been given a separate name on account of its being within the geographical limits of Korea State. This coalfield has an almost flat coal seam, 5' to 8' in thickness, whose ash content is barely

12 per cent. A most unique feature of this coalfield as well as that of Kurasia field is the presence of dykes of pure sandstone which have cut across the coal seams.

(5) *Kurasia Coalfield*.—This coal area has two coal horizons in the east (or Kurasia area) with seams up to 18' in thickness. In the west (or Chirmiri area) there is 36' of coal in three beds in strata 48' in thickness. Some of the coal is of excellent quality. The calorific values of many seams are near about 7,000 calories. The beds dip approximately 1:30 s.w.

(6) *Koreagarh Coalfield*.—The area has not been properly explored but several coal seams 3 to 5 feet in thickness are known from this area. It is about 6 sq. miles in extent.

(7) *Bisrampur Coalfield (Sirguja State)*.—Several coal seams 2 to 6 feet in thickness occur near Rajansuhi; two coal seams occur near Bagara, and several coal seams occur near Kotea. A coal seam occurring near Gagar nala shows only 7 per cent. ash. In the Mahan river there is a coal seam 7'-3" in thickness. Its calorific value is about 6,000 calories. There are other seams exposed near Tulsī in the Rer River near Pundih. This field has not yet been properly prospected. Its area is about 400 sq. miles.

(8) *Bansar Coalfield*.—This is another not yet properly surveyed coalfield.

(9) *Lakhanpur Coalfield (Sirguja State)*.—Its area is about 135 sq. miles and it has been divided into eastern and western sections. The eastern section is called the Lakhanpur section, 50 sq. miles; and the western area is called Lingah section, 85 sq. miles. The eastern section is said to contain two coal seams, 2 ft. and 5 ft. 6 inches in thickness. The western section has also two seams, one of which is 3 ft. 6 inches in thickness and the other one 7 ft. 6 inches. The latter shows 20.5 per cent. ash. Two more seams whose ash percentage is near about 12 have been found in the stream near Salih.

(10) *Panchbahini Coalfield (Sirguja State)*.—It has an area of $4\frac{1}{2}$ sq. miles. Two coal seams about 3 feet in thickness are known in this coalfield. They are both said to be of good quality.

(11) *Damhamunda Coalfield (Sirguja State)*.—It has an area of about $4\frac{1}{2}$ sq. miles. Several thin coal seams are known in this coalfield.

(12) *Sendurgarh Coalfield (Sirguja State)*.—It has an area of about 20 sq. miles. Several valuable coal outcrops have been found in this field. One near Bukbhuku is 10 feet in thickness. It is non-coking and possesses 23.1 per cent. ash. A 4-foot seam occurring near Amlibahara shows 6.4 per cent. ash. The reserve of coal is roughly 40 million tons.

(13) *Rampur (Sirguja) Coalfield*.—The eastern (Rampur) section of the field is separated from the Mand River section by the central section which shows supra-Barakar rocks. The seams are usually thin but one seam, 12 feet in thickness, and another 9 feet thick are known. The quality of coal is variable, some being as low as 5 per cent. in ash; others show 30 per cent.

(14) *Korba Coalfield*.—The coal-bearing rocks of this coalfield occupy roughly about 200 sq. miles. Korba is situated at about 24 miles west of Champa railway station, B. N. Rly. On the west bank of Hasdo River the Korba Seam, said to be 70 ft. thick appears in two separate outcrops. Another 5-foot seam was discovered by Lala Hiralal in the Aharan River bed. This seam shows 6.8 to 13.41 per cent. of ash. A 22-foot seam is said to outcrop in Ganjar nala, 22 miles west of Korba. Further coal outcrops are reported from near the junction of Ganjar and Dongara nalas; from Ghoghri nala, a mile north west of Bagdewa, and another one in the Kholar nala about a mile north-east of Rail. The thick seams at Jatraj and Kusumuda are perhaps the same seam as the Korba seam. The reserves of coal in this field are estimated to be 250 million tons, of which 25 million tons are of good quality.

The Sonepuri or Upper Kusumdia seam has a thickness of 72 feet with about 28 feet of coal in three sections. These three sections—bottom, middle and upper respectively—show 9,000, 8,800 and 10,500 B.T.U.'s. In the vicinity of Bhairotal, south-east of Ghordewa there is a 20-foot coal seam between the Korpa seam and the underlying 5-foot seam. The latter is called Ghordewa seam. Its calorific value is about 11,000 B.T.U. It is quite up to mail standard. One or two other seams are suspected in Ghordewa area. A very important 6-foot seam occurs in the Phulukdih nala, about a mile west of Rajgammar village. Its calorific value is approximately 11,000 B.T.U. This coal-

field has not yet been fully explored but the area seems to be full of promise. Near the railway there is an excellent outcrop of large Vindhyan limestone bed of good quality suitable for cement industry. The coalfield seems to be free from large faults and no dykes have been discovered in the area covered with coal-bearing beds.

(15) *Mand River Coalfield*.—The Korba coalfield is the western extension of the Mand River coalfield. A narrow strip of Barakar rocks connects Mand River coalfield with Korba coalfield. The area covered by Barakar in the Mand Valley coalfield is near about 200 sq. miles. Several good outcrops occur in the northern part of the field in the bed of the Gopal nala. In this area there seems to be four coal seams folded in a syncline. Some of the seams are 16 to 20 feet thick. Borings proved two seams 19 and 13 ft. thick and they were named Jubilee seam and Hiralal seam, the latter after the name of the discoverer. The Hiralal seam shows 35 per cent. ash.

(16) *Kankanee Coalfield*.—Kankanee is a Persian word meaning "mining." Therefore, although no coal seams have been discovered in this field, it certainly requires investigation. It is situated 12 miles north-west of Raigarh.

(17) *Raigarh-Hingir Coalfields*.—In the Raigarh area in Raigarh State the Barakars possess an approximate extent of 200 sq. miles. There are several coal seams in this area but they are mostly thin. A 6-foot seam in the Kalo river and two seams of flaky coal each about 6 ft. thick occurring near the mouth of the Bendra river seem to be promising. The Raigarh fields have not yet been properly prospected.

(18) *South Raigarh Field*.—The extent of this coalfield is about 25 sq. miles. In a bore hole near Dibdora a 14-ft. seam was encountered.

II. *Satpura Coalfields.*

(1) *Mohpani Coalfield*.—This coalfield belongs to the G.I.P. Railway. This has four coal seams with calorific value varying between 6,000 and 7,000 calories. The estimated reserve of coal in this field is 4 million tons.

(2) *Sonada Coalfield*.—No workable seams of coal have been discovered in this field. Thin coaly layers occur in typical Talchir rocks which contain profuse im-

pressions of fossil leaves. This coalfield too has not yet been fully explored.

(3) *Shahpur Coalfield*.—This coalfield has three coal-bearing areas. They are:—The Gurgunda; Mardanpur; and Katasur areas. The Barakars occur in a narrow strip; the seams are thin, barely 5 ft. thick.

(4) *Dulhara Coalfield*.—It has an area of $1\frac{1}{2}$ sq. miles. Boring proved the presence of one seam—6 feet thick.

(5) *Pathakhera Coalfield*.—It has an area of 16 sq. miles. A boring near Pathakhera proved three seams—4'-8", 6' and 14' thick. About 15 million tons of fair quality coal are available in this field.

(6) *Bamhanwara Coalfield*.—Barakars of this coalfield have an area of 2 sq. miles. No coal has been discovered but fragments of coal have been found in the bed of a stream.

(7) *Upper Tawa Valley Coalfield*.—Very few details are available of this coalfield. One seam, 5 ft. thick, has been reported from near village Tandsi.

(8) *Kanhan Valley Coalfields*.—These coalfields include a large coal bearing area in the Central Provinces which extends from the Kanhan River to Pench Valley, which has been sub-divided into the following six areas:—

(i) *Damua-Kalichhappar*.—The Barakars of this area extend east-west and dip towards north. There is a coal seam near Kalichhappar which gently dips northwards. It is 9' thick near the outcrop but at depth it becomes 15' thick. A fault half a mile north of Kalichhappar has affected this seam. Perhaps large quantities of coal occur close to the surface to the north of the fault. There are three coal outcrops near Damua. One of them which is 14' thick is being worked in the Kanhan Colliery. The calorific value of this coal is 6,500 calories. It is good coking coal. The ash percentage of the coke is 25.7.

(ii) *Ghorawari-Nimkhera Area*.—This area occurs east of Damua area. The seam worked in Ghorawari Colliery is 15' deep but only about 8' of the coal seam is worked. Its calorific value is 6,348 calories and its coke shows 27.6 per cent ash. There are two more coal seams below Ghorawari seam. Both are 10' thick. Several other minor seams are also visible in the neighbouring rivulet. Perhaps the Damu seam

and the Ghorawari seam are one and the same seam deviated by faults.

(iii) *Panara-Jinnaur Area*.—One coal seam which is about 14' thick is worked in this area in the Junnor Deo Colliery. This seam probably occupies a higher horizon than the Ghorawari seam. The calorific value of the coal is 5,226 calories. The area is disturbed by several east-west faults.

(iv) *Dalta-Jamai Area*.—The Dalta seam is worked in Dongaria Colliery, and has been found also in the Takia nala, and near Badeo village. The coal is of caking quality; its calorific value is 3,602 calories. There are two seams supposed to be of poor quality coal occurring below this Dongaria seam. One of these seams is 10' thick.

(v) *Jamkunda Area* and (vi) *Hingladevi*.—The two areas are more or less continuous. In the local language of the Gonds, "hing-laj" means coal, and the presence of the shrine of Hingladevi in the locality perhaps indicates that the Gonds, from whom the name Gondwana originates, did possess some knowledge of the usefulness of coal. In the Ghogri colliery of this area there is a coal seam 5'-9" thick. Its calorific value is near about 5,500 calories. Several boring operations carried out near Jamkunda and Ambara proved the presence of four coal seams, each less than 5' thick. A mine at Nazarpur showed the presence of the top seam 5' to 6' thick.

(9) *Pench Valley Coalfields*.—In these fields above the Gondwanas occur Deccan Trap flows with a conglomerate sometimes occurring below it. About 9 to 10 different coal areas occur in this region. These are:—

(i) *Gajandoh Area*.—A 5' coal seam under 8' of shale is recorded but the beds dip northwards under trap and exploration in this area will mean boring through the trap to prove the continuity of beds.

(ii) *Barkuhi Area*.—This area occurs near Barkuhi Railway station. One coal seam about 7' in thickness is worked in this area, and another 4' seam is said to occur above it.

(iii) *Bhandaria-Bhutaria Area*.—In this area in the Gogra nala about a mile south-west of Parasia a coal seam about 8' in thickness is known.

(iv) *Chandameta-Dongar Chikli Area*.—Several seams of which one is 9'-6" thick have been proved in a bore hole at Chan-

dameta. It is the same series of coal as in Kanhan but it is non-coking. This is perhaps due to its high moisture content. About 15 million tons of coal are available in this area.

(v) *Eklaira-Newton Chikhli Area*.—The area is disturbed by parallel faults. The coal seam has about 8' of good quality of coal. Its moisture content is high and is non-coking.

(vi) *Parasia-Khirsadoh Area*.—Three seams of coal, one 6', next 4' and the third 4½' thick, have been proved in this area. The top seam is evidently the main seam of the Pench Valley field.

(vii) *Rawanwara-Harrai Area*.—A thin seam of coal of calorific value near about 6,300 calories occurs in this area.

(viii) *Dighawani-Chhinda Area*.—In a section 15'-6" in thickness, three seams of coal of total thickness 12'-3" occur in this area. South of Pench or Setia-Harrai fault, the alluvium obscures the area.

(ix) *Sirgora-Haranbhata Area*.—In a boring about 60' deep, two coal seams one of which is the main seam of the Pench Valley fields have been proved in this area.

III. Wardha Valley Coalfields.

Coal was discovered in the Wardha Valley in 1831. Nine separate coal-bearing areas occur in this area, of which the following six are the important ones:—

(1) *Bandar Coalfield*.—Four coal seams, one 7' thick at 85', next 17' thick at 129', the third one 3' coaly shale at 243' and the fourth one 6' thick at 162' have been proved in a boring near village Morepur in this area. As the area lies at a distance of about 30 miles from the nearest railway line, it is still lying unworked. The total reserve of coal is estimated to be 108 million tons.

(2) *Warora Colliery Area*.—The area is estimated to be about 420 acres. In this there are two seams, viz., one 15' seam and the other 10' seam. The calorific value of these coals is near about 5,500 calories. Borings at other areas have proved the presence of four seams. About 12 million tons of coal are available in this area.

(3) *Rajur or Wun Coalfield*.—It is situated in the Yeotmal district of Berar. By boring, 27 to 31 feet of coal was found at 77' from the surface at Pisgaon; 18 to 30

feet of coal was found within 160' from the surface at Rajur; similar was the result of boring within 245' from the surface at Ganeshpur. The Rajur coal has a calorific value of 6,540 calories. It is similar to the coal found at Warora, Ballarpur and Ghugus. The reserves of coal in this field are estimated to be 240 million tons.

(4) *Ghugus-Telwasa Coalfields*.—Mr. Hughes proved 62' of coal with partings in a boring at Junara opposite Telwasa where a coal seam about 59' thick has been found on the east bank of the Wardha River. In a new boring near Telwasa three coal seams of workable thicknesses 8', 21' and 13' were found within 125' from the surface. The 13' section is the best coal. At Ghugus there are two thick seams of coal, one of which is 37' and another 33'. The calorific value of Ghugus coal varies between 6,100 and 7,000 calories. The coal is of high moisture non-coking variety. There are about 1,500 million tons of coal in these fields. The thick seams of Ghugus extend southwards for a long way but their presence has not yet been proved. The Kamthi strata overlap and conceal the coal seams. Here we have perhaps an extensive concealed coalfield about 100 square miles in area. We have here a very attractive coal proposition.

(5) *Chanda Coalfield*.—To the east of Chanda town in Mahakali colliery, two seams, one 19' thick at 81' and another 26' thick at 120' have been proved by the Jharpat nala borings. In this area also a large portion of the coalfield is concealed under Kamthi rocks.

(6) *Ballarpur Coalfield*.—A boring near Sasti proved a coal seam 32' thick at 62'. The calorific values of Ballarpur coals vary between 6,000 and 6,400 calories. The reserves of coal in this field are 40 million tons, but if the total area is included, the reserves will be of the order of 2,000 million tons.

F—PRANHITA-GODAVARI VALLEY COALFIELDS

Gondwana strata consisting chiefly of Kamthi sandstone, continue from the Wardha Valley through H.E.H. the Nizam's Dominions into Madras and occupy an area of about 4,500 sq. miles. Of these about 200 sq. miles lie within the Central Provinces, 600 miles within Madras and the remaining 3,800 sq. miles lie in Hyderabad.

The coalfields should be divided into two groups. They are (I) those situated within H.E.H. the Nizam's Dominions and (II) those in the Madras Presidency.

1. Coalfields of Hyderabad (Deccan)

(1) *Sasti Area*.—The Sasti coal is often called Ballarpur coal. It has an area of about 200 sq. miles west of Wardha River, south-east of Sasti. Near about Sasti, there seems to be altogether 50' of coal. Shafts sunk at Sasti met a 27' seam at a depth of 78'. The greater portion of the thickness consists of hard good coal. A 60' seam was proved at Paoni. The Sasti coal has a calorific value of about 6,175 calories.

(2) *Antargaon-Aksapur Coalfield*.—The Barakar outcrops south of Antargaon are overlapped by Kamphthis. A 6' seam occurs near Antargaon, south of Lathighat. It contains approximately 20 per cent. ash. There is an anticline, west of Antargaon and in the Anar range a 5' seam outcrops a short distance up the hill.

(3) *Tandur Coalfield*.—Coal measures extend through Tandur to the east of Belampalli Railway station and there is another outcrop near Waripet. A coal seam 15' thick occurs near Aregura (Kairgura). It was analysed and found to contain 12.2 per cent. ash and 9.4 per cent. moisture. Two workable coal seams have been found within the Barakar outcrop. The thickness of these coal seams vary and their average analysis shows that their calorific values are near about 6,460 calories (dry basis). There are possibilities of coal in this area in the south near the villages of Sarangpali, Yenkatapuram and Tetmatla. As coal occurs near Chinur (the following area) on the upthrow side of a fault, it is expected that coal will be found in an area of 100 sq. miles between Tandur and the Godavari River.

(4) *Chinur Area*.—Chinur is situated on Kamphthi rocks but on the west of it Barakar rocks appear. They dip north-east and strike south-east across the Godavari to beyond Sandrapali. The main coalfield seems to be lying downstream near Sironcha. The total length of Barakar outcrops between Chinur and Sandrapali is 14 miles. It is quite possible that coal-bearing rocks may be present within workable depth under the Kamphthis near Sironcha, this may give an area of 100 sq. miles. South of the Godavari, above its junction with

the Prantha River and west of the river below the confluence, there is a large outcrop of Kamphthi rocks. The Barakars are hidden below the extensive occurrence of Kamphthis, but there can be no doubt about the occurrence of coalfields in the Barakars below the Kamphthis in this hidden coalfield.

(5) *Karlapalli Coalfield*.—The Barakar rocks occur in the Karlapalli rivulet, a tributary of the Pengadi River. Coal was discovered in this area by the local Koi people. This coalfield has an area of about 1.56 acres. It has two coal seams 9' and 6' in thickness, but as the dips are high, the area is not worked. The total coal from these two seams is estimated to be 3½ million tons.

(6) *Bandala Allapali Area*.—Coal was found by the local Kois many years ago, but no specimens were analysed, the seam is reported to be 6' thick. The area is somewhat isolated; it still requires to be geologically investigated.

(7) *Lingala Area*.—Fragments of coal were found in the Godavari River bed near Lingala long before 1857. An exploration proved the presence of four coal seams all dipping westwards—two 2' seams on the British India bank—the thickest one, 5' thick, outcropping in the middle of the river and a two-foot seam on the Hyderabad bank.

(8) *Singareni Coalfield*.—This coalfield shows the presence of Lower Gondwana rocks near Yellandlapad, about 5 miles north-north-east of Singareni. The coalfield has an area of 19 sq. miles, about 11 miles long and two miles wide. Four seams have been proved by boring in this area. The top seam is 6' thick and the coal is good. The next two seams are thin seams. The bottom one is a thick seam consisting of about 34' of solid coal. Recent borings have proved six seams below the thick seam, of which the one (King seam) above the bottom seam 6' to 7' thick is of excellent coal. It has about 7.6 per cent. moisture and about 10.6 per cent. ash. Its calorific value is about 6,000 calories. The total reserves of coal in the thick seam and King seam were first estimated to be 156 million tons but due to subsidence it is believed that only 36 million tons of coal actually are workable.

(9) *Kottagudem Coalfield*.—This place is 24 miles east of Singareni coalfield. The

excellent Singareni coal seams have been proved here at a depth of about 400'. The strata are very much watered. This water trouble has so far kept people off from this promising coalfield.

(10) *Kannegiri Coalfield*.—Barakar rocks have been proved in this coalfield, but no coal has so far been proved. No borings appear to have been put down, though the Mureru Valley of the Kottagodem coalfield where coal has been proved in a shaft lies only 10 miles north of this area.

(11) *Damarcherla Area*.—Three coal seams have been proved by borings in this area of which the lowest one, 6' thick at the depth of 314', is promising. The seams must be occurring at a shallower depth in the British territory near Totapalle.

(12) *Bedadanuru Area*.—It also contains coal outcrops in the Barakars on the British (Madras) side which, however dip under Kamthis towards Hyderabad. Four thin seams were found here by boring to a depth of 188'. One of the seams is 4½' thick. This area too has not been properly explored. In order to prove this area and that east of Ashwaraopet, a 1,500' boring is necessary.

II. Coal in Madras Presidency.

All the Barakar outcrops of the Madras Presidency occur in the East Godavari District. The localities are Lingala, Badrachellam and Bedda danol. They all are on the borders of Hyderabad State, in which direction the coal-bearing rocks extend below the Kamthi rocks. Four seams are found in Lingala area, 3 of which are only 2' thick but one is a 5' seam. The last, however, outcrops in the middle of the river. The coal-bearing rocks within the British territory at this place have an area of about 5 sq. miles. The coal is of saleable quality. In the Ganaparam area opposite to Damarcherla area of Hyderabad, a seam of fine quality coal has been found opposite the village Rajahzompalli. Its average thickness is 5'-6". Several thousand tons of coal were raised from this area in the nineties of the last century. The extent of the coal-bearing area is about 10 sq. miles and it is estimated to contain about 24 million tons of coal.

G. COAL IN UNITED PROVINCES

The Singrauli coalfield of South Rewah extends eastwards into the Mirzapur District of U.P. This portion of the field had

been called the *Kota field* by Mallet in 1872, who noticed several outcrops of very thin seams of poor quality coal, two or three being of fair quality and of workable thickness. Public attention has been recently drawn again to this area by Dr. V. S. Dubey (*Q. J. Geol. Min. Met. Soc. Ind.*, 1942, 14, 45). Information regarding the U.P. portion of this coalfield is still incomplete.

The Tertiary Coalfields of India¹⁰

A. ASSAM.

(1) *Makum Coalfield*.—This field occurs near the southern boundary of the district of Lakhimpur and Sibsagar. The most valuable deposits occur near Tirap and Namdang. The length of this field, Tirap to Namdang, is about 5 miles. One coal seam 15' to 80' in thickness (average thickness being 50 ft.) occurs in this area. The dip is about 40°. It is low-ash high sulphur coal, the ash and sulphur contents being both near about 2 per cent.

(2) *Jaipur Coalfield*.—This coalfield has been divided into three parts by the Dihing and Disang Rivers. It occurs along the western foot of the Tipam hills. The dip is 30° to 80° towards east. In the Disang River section 6 seams of total thickness of 45' have been observed. The quality of the coal is quite good, its ash percentage being near about 4 per cent. but this coal also like other Tertiary coals of Assam, is high in sulphur.

(3) *Namchik River Coalfield*.—Several coal seams, one of which is 26' in thickness, have been reported from this area. The quality of the coal is excellent. The dip of seams is 40° to 60°.

(4) *Nazira Coalfield*.—This coalfield occurs 20 miles south-west of the Jaipur coalfield. A large number of coal seams occur in this field, but only five of them, having an aggregate thickness of 73', are workable. An average analysis of coal of this area shows that its ash content is near about 3 per cent. and fixed carbon near about 58 per cent.

Other important coalfields occur at Janji, Disai, Mikir hills, Dissoma River, Diyang River and Nambor and Doigrung areas of Upper Assam. Several coal areas—Baljong, Dogring, Waimong (Chutmang of Kailas)—have been discovered in the Garo hills, east of Simsang River. There are generally two seams in these areas, the upper one about 3-4½ ft. and the lower 5-6 ft. thick.

(5) *Khasia and Jaintia Hills Area*.—The coals of these hills area of Assam are of both Tertiary and Cretaceous age. Following are the most important coalfields of this area:—

(i) *Cherapunji Area*.—A seam 3' to 7' in thickness with coal containing only about 1 per cent. ash occurs in this area, usually 10' to 15' above Nummulitic limestone. The area of the coalfield is only about ¼ sq. mile.

(ii) *Lairangao Area*.—This field lies about 7 miles north of Cherapunji. The seam is 3' thick dipping at low angle towards south. About half a million tons of coal is available over an area of about half a square mile.

(iii) *Maosandram Area*.—This is a small coalfield only 22 acres in area. The seam is as much as 7' in thickness and the coal is of poor quality; the average thickness is only 2'.

(iv) *Um Rileng Area*.—This is at the foot of the Dinghu hill, 7 miles north-west of Shillong. The area of the coalfield is about half a square mile. The average thickness of the two seams is 9' to 10'. An analysis of the coal shows 6.23 per cent. ash, 32 per cent. fixed carbon, 46 per cent. volatile matter and 17 per cent. moisture. The coal is non-caking due to high moisture content.

(v) *Lakadaung Area*.—The coal seam is found outcropping round the edges and near the tops of small plateaus. Umlotodo and Umat being the two most important plateaus. The thickness of the seam varies from almost nothing up to 10'; the average being 2'. The area of the coalfield is ½ sq. mile. The coal is bright and is of good quality. The area is situated near the southern edge of the Jaintia Hills.

B. BALUCHISTAN

(1) *Khost Area*.—Coal is found over a considerable area of the country, but the seams are thin, near about 3' in thickness. The coals are low in ash, high in sulphur and they cake well.

(2) A number of thin seams of coal occur in Sor Range to the east of Quetta. In a boring in this area 2 miles south of Mach about 5' of coal was encountered. The coals of these areas are, again, like other Tertiary coals, low-ash high sulphur coals.

C. KASHMIR¹¹

Important seams of Tertiary coal occur in the Jammu Province of Kashmir. The Jammu coal measures occur on the north-east and south-west flanks of elongated domes, which may be divided into three groups :—

(i) The southern main group west of Chenab River which comprises Kalakot, Metka, Mahogala Chakar and Dandli coalfields.

(ii) The more northern group of Dhansal-Sawalkot coalfield.

(iii) Area east of Chenab consisting of the Ladda coalfield and other coal-bearing areas.

In Kashmir two coal measures (both Tertiary) have been discovered. Most of the coal of these fields is anthracitic, coming about midway between bituminous coal and pure anthracite. Much of it is coking. These coalfields are not yet developed for want of transportation.

D. NORTH-WEST FRONTIER

The most important and promising coal-bearing area in this province is in the Kohat District, just north of Baroch gorge. It has not yet been fully proved. Coal also occurs in the Dore River valley of the Hazara District, but the deposits are not regarded to be commercially workable.

E. PUNJAB¹²

(1) *Dandot Coalfield*.—The coal is of Lower Eocene age. It occurs just below the Nummulitic limestone above the Salt Mines of Khewra. The area of the coalfield is about 2 sq. miles and the reserve is about 5 million tons. The coal is a low ash coal but has a high percentage of sulphur and is liable to spontaneous combustion. The Dandot seam has been proved at several places in the eastern half of the Salt Range—Bhaganwala, Dandot, Pidh, Dhak, Chittidand, Nurpur, etc. Its average thickness is $2\frac{1}{2}$ to 3 ft.

(2) *Isha Khel Coalfield*.—The most important mine in this area is the Makarwal colliery. The Makarwal seam of the Trans-Indus Salt Range occurs at the base of the Eocene. The seam is usually 4 to 7 ft. thick, the maximum thickness being about 12 ft. in the Lumshiwal mine. Its coal is a low ash coal, high in sulphur. Some of the coal of the Trans-Indus range, namely, that occurring close to Kalabagh, is of Jurassic

age. It occurs as 'pockets' of lignified wood, often giving good analytical results.

F. RAJPUTANA

Lignitic coal of considerable importance occurs below the Nummulitic limestone near about Palana in the sandy desert of Bikaner State. The seam is 4' to 8' thick. It is a low-ash friable coal which can be used with advantage when briquetted. The ash content is near about 4 per cent.

G. SIMLA, HIMALAYAS

The author discovered a very much disturbed seam of coal full of pyrite nodules, more a source of sulphur than coal, in the southern portion of Mandi State near its junction with Suket State. Dr. Rajnath has discovered a 2' coal seam at Dehlag in Bilaspur State. An analysis of the coal showed (on moisture-free basis) 60 per cent. fixed carbon, 29 per cent. ash and 11 per cent. volatile matter.

H. SIND

Coal seams have been recently discovered under Nummulitic limestone of Sind, near Karachi.

The Cretaceous Coalfields of India

ASSAM

Many of the coalfields of Assam, e.g., the Daranggiri and Rongrenggiri coalfields of the Upper Simsang Valley in Garo hills are now regarded to be of Eocene age. Other fields are the following :—

(1) *Wapung and Lenkensmit Coalfields*.—The coal of this area is of excellent caking quality but nowhere are the seams more than 5' in thickness. Owing to the pyrite inclusions, the value of the coal has been very much affected.

(2) *Umbley River Coalfields*.—Four seams of total thickness of about 20' occur in this area. The area of the field is about 30 sq. miles. It is situated in the south-west part of the Khasia hills. The coal is of good quality. Its ash content is about 6 to 8 per cent. Its colour varies from black to brown. It is bright and like Um Reling coal, contains fossil resin.

Methods of Mining Coal

Coal mines in India are almost universally worked by Board and Pillar method. This consists of driving tunnels, technically called galleries, along and across the extension of the coal seam. Usually these tunnels (galleries) are driven 40 feet apart. Galleries

driven towards the inclination of the coal seam are called "dip galleries" and those driven along its horizontal extensions are called "level galleries." Particular dip galleries which are used for haulage of coal or as the main walking roads for the miners, are called "main galleries." In the first stage of working of a coal mine due to the construction of so many galleries, the coal seam becomes sub-divided into so many coal cubes which are 40' long x 40' wide x as high as the height of the seam but not exceeding 10' in height, and so many tunnels which are also not usually more than 10' wide and 10' high. These coal blocks of the size 40' x 40' (more or less) are called coal "pillars." In the first stage of working about 40 per cent. of coal is extracted, 60 per cent. of coal remains in the pillars. The drawing of coal from these pillars marks the second stage of working of the coal mines, called the "depillaring stage." Most of the coal is extracted at that stage, but still it is usual that about 20 per cent. of coal is left behind in the mines. Recently, in order to encourage conservation of coal and minimize accidents in coal mines, the Government of India have introduced the voluntary *Sandstowing Act*. Sand-stowing consists of filling up the empty spaces in mines created by the extraction of coal bit by bit by sand. The filling up of the empty spaces and the extraction of coal go hand in hand. In this way sudden collapses inside the mines become impossible, danger to life is minimized and coal extraction becomes maximum. It is quite possible to extract even more than 90 per cent. of coal from a seam by judicious sand-stowing.

When the over-burden is soft, coal seams are quarried or, technically speaking, coal seams are worked by "open cast method." As long as the thickness of the over-burden is not more than that of the coal seam, quarrying remains economical and it costs less than underground mining of coal. Quarrying has also many other advantages over underground mining but those considerations do not fall within the scope of this note.

Production and Reserves

The production of Indian coal according to Provinces has been shown in the accompanying Table III for the period 1924-38. Table IV gives the output of coal in 1938 from the various coalfields of India and the percentage of Indian total which each of these fields contributed in that year. It will be seen from the table that the Gondwana

TABLE III. Showing the Production of Coal in India from 1924-1938.

Year	GONDWANA COAL						TERTIARY COAL					Total
	Bengal	Bihar	Central India	Central Provinces	Hyderabad State	Orissa	Eastern States Agency	Assam	Baluchistan	Punjab	Rajputana	
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
1924	6,035,347	13,046,975	235,298	679,081	644,775	54,362		334,842	40,557	80,422	21,870	21,174,029
1925	5,729,686	13,070,000	219,106	708,554	677,877	52,675		118,842	34,797	74,652	28,153	30,904,352
1926	6,124,884	12,925,936	216,708	635,252	637,779	42,643		301,061	15,586	69,043	31,375	30,996,157
1927	6,472,036	13,550,609	217,661	666,758	707,213	50,211		323,342	14,444	62,703	17,358	30,082,336
1928	6,460,490	13,937,096	218,750	732,353	734,765	69,860		398,085	17,931	64,152	27,358	32,542,336
1929	6,628,053	14,185,916	205,133	822,331	815,875	84,279		322,512	16,222	43,136	35,276	32,418,712
1930	7,218,691	14,055,670	193,233	955,888	812,298	106,892		359,040	15,884	50,619	35,123	32,810,034
1931	6,330,713	12,638,733	226,928	1,004,391	757,575	173,532		275,021	15,554	54,840	38,128	31,764,435
1932	6,419,007	10,937,728	240,488	1,163,096	781,121	273,084		210,035	18,978	73,857	37,043	30,753,381
1933	5,691,189	11,257,984*	252,768	1,500,911	753,402	Included in Bihar.		194,154	14,462	94,899	37,194	30,789,163
1934	6,159,486	12,630,409*	289,381	1,842,497	769,636	Included in Orissa.		189,577	14,706	123,256	36,516	32,057,467
1935	6,682,752	12,747,340*	329,369	2,118,677	729,414			220,737	9,558	144,423	34,425	32,616,695
1936	6,667,841	12,047,975*	329,488	2,507,982	852,739			203,239	8,099	156,831	30,177	32,616,695
1937	6,527,820	13,836,717	334,291	1,504,159	1,076,241	47,127		248,561	17,479	166,632	32,169	32,616,695
1938	7,745,372	15,364,079	336,593	1,658,626	1,211,163	44,425	806,432 1,244,988 1,463,693	778,328	21,882	184,028	34,717	28,342,966

* Includes production figures for Orissa.

Coalfields of India are responsible for the production of more than 98 per cent. of Indian coal. The average pitmouth price of coal has been Rs. 7-7-0 per ton in 1920 ; Rs. 3-14-0 per ton in 1929 ; Rs. 3-12-0 per ton in 1938 and Rs. 3-9-3 per ton in 1939.

Mr. N. N. Chatterjee in his presidential address to the Geology Section of the 32nd Indian Science Congress, Nagpur (1945), has discussed fully "India's Position with Regard to her Coal Resources." According to him India's total reserve for Gondwana coal of all grades up to one foot thickness and up to a depth of about 2,000 ft. comes to 60,000 million long tons. As mining is not practicable with less than 4 ft. thick seams the workable total reserve is at once reduced to 20,000 million tons of coal having not more than 25 per cent. ash. The reserve of Tertiary coal comes to 2,300 million tons approximately.

TABLE IV. *Showing the Output of Indian Coal-fields in 1938*

A. Output of Gondwana Coalfields.		
Coalfields	Tons	Per cent. of Indian total
<i>Bengal, Bihar and Orissa:</i>		
Bokaro	2,007,016	7.08
Giridih	636,371	2.24
Jainti	42,900	0.15
Jharia	11,144,462	39.32
Karanpura	625,914	2.21
Daltonganj	393	
Rajmahal Hills	1,475	0.01
Rampur (Raigarh-Hingir)	44,425	0.16
Raniganj	8,650,920	30.52
<i>Central India</i>		
Sohagpur	263,894	0.93
Umaria	72,699	0.26
<i>Central Provinces</i>		
Ballarpur	279,353	0.98
Pench Valley	1,369,208	4.83
Shahpur (Betul)	5,288	0.02
Ycotmal	4,777	0.02
<i>Eastern States Agency.</i>		
Korea	1,012,858	3.58
Raigarh State	2,600	0.01
Talcher	448,235	1.58
<i>Hyderabad:</i>		
Kothagudam	95,248	0.34
Sasti	90,782	0.32
Singarem	690,850	2.43
Tandur	334,283	1.18
Total	27,823,951	98.17

B. Output of Tertiary Coalfields.		
Coalfields	Tons	Per cent. of Indian total
<i>Assam.</i>		
Khasi and Jaintia Hills	16,660	0.98
Makum and Lakhimpur	232,904	
Naga Hills	28,764	
<i>Baluchistan:</i>		
Khost	7,165	0.08
Sor Range, Mach and Kalat	14,717	
<i>Punjab:</i>		
Jhelum	66,808	0.65
Mianwali	111,925	
Shahpur	5,295	
<i>Rajputana:</i>		
Bikaner	34,717	0.12
Total	518,955	1.83

Utilization of Coal

Coal is cheapest in India. India's coal is at present mostly utilized for steam raising and as domestic fuel. It is totally forgotten in India that "Coal is an immensely valuable chemical substance which only a primitive industrial civilisation would treat as fuel" (D. L. Hodgrove). A very small portion of coal (about 5 million tons) is coked in order to supply the necessary coke to the blast furnaces of Jamshedpur, Kulti and Burnpur. There are gas supply companies in the bigger towns of India like Calcutta and Bombay, which consume a very small quantity of high volatile coal for their gas factories. The metallurgical hard coke is partly prepared by the metallurgical companies themselves. Large supplies are also obtained from various coke ovens situated in the coalfields. It is most unfortunate that although the iron ore reserve of our country is sufficient to meet the country's demands for many centuries and it is admitted on all hands that the known reserve of extractable high grade metallurgical coal is only about 800 million tons, under the present market conditions of coal it is mostly metallurgical coal which is being burnt away in boilers and various other purposes for which the metallurgical coal should not be used. If the consumption of coking coal continues in the same way, as at present, very soon the country will be faced with a famine of metallurgical coal. In the interest of the country, it is most necessary that the high grade metallurgical coal of India should be conserved. "Conservation of coking coal is of vital importance from the standpoint of India's industrial future."

References

- Arber, E. A. N., *Natural History of Coal* (1911); Redmyne, Sir R., *Fuel*.
- Woodward, H. B., *History of Geology* (1911).
- Fox, Sir C. S., *Trans. Min. Geol. Inst. Ind.*, 1929, 24, 106; Roy, S. K., Discussion on the above paper.
- Bose, P. N., *Rec. Geol. Surv. Ind.*, 1890, 33, 237.
- Fox, Sir C. S., *Mem. Geol. Surv. Ind.*, 1934, 59.
- Redmyne, Sir R., *Fuel*, p. 20-21.
- Stutzer, *Lagerstätten der Nicht-Erze*, II, Berlin, 1923; Arber, E. A. N., *Natural History of Coal*, 1911.
- Fox, Sir C. S., *Mem. Geol. Surv. Ind.*, 1930, 56.
- Gee, E. R., *Mem. Geol. Surv. Ind.*, 1932, 61.
- Simpson, R. R., *Mem. Geol. Surv. Ind.*, 1922, 41, pt. 1.
- Middlemiss, C. S., *Mineral Survey Reports, Jammu and Kashmir Government, on Coalfields*, 1929.
- Gee, E. R., *Trans. Min. Geol. Inst. Ind.*, 1938, 38, 278-303.

NATIONAL PATENT PLANNING COMMISSION, U.S.A.

THE United States National Patent Planning Commission has published two reports on the American patent system. In its first report the Commission deals with certain aspects of the general operation of the patent laws. The second report is concerned mainly with the administration of patents owned by the Government.

Many of the problems discussed in the second report and the conclusions arrived at are likely to be of interest to those concerned with the development of inventions in India. A brief review of some of the more important findings is given below :

1. The general policy of the Government with respect to patents owned by it should be to make the patented inventions available for commercial and industrial exploitation by anyone. But it often happens, particularly in new fields, that what is available for exploitation by everyone is undertaken by no one. There undoubtedly are Government-owned patents which, because they call for a substantial capital investment, private manufacturers may be unwilling to commercialize under a non-exclusive licence. Hence the Commission recommends that the Government should have the power to grant exclusive licences or otherwise dispose of patents under appropriate conditions and safeguards whenever it is determined that such action is necessary to assure the commercial development of an invention of a Government-owned patent.

2. The Government should not attempt to utilize its patents solely for profit. The main object should be to insure that the invention is brought into commercial channels at the earliest possible moment. It is believed, however, that there should be no objection to recovery by the Government, through sale or licensing, of all or a substantial part of public funds expended in the research which resulted in the invention.

3. There should be a central body for controlling the administration of Government patent policies and practices.

The following passage from the testimony of Dr. Vannevar Bush, Director of the Office of Scientific Research and Development may be quoted :

“The principal difficulty lies in the fact that there is now no machinery provided by law under which the patents owned by the Government can be administered for the best interests of the public. It is not sufficient for a department merely to hold a patent and do nothing, or even to issue licences freely to all comers; such action in effect often vitiates the intent of our fundamental patent law. A patent needs to be exercised in order to be effective ... Yet, to-day, when a patent is assigned to the Government, its commercial benefit may be completely lost.”

The central body will have the following principal powers, functions and duties :

- (a) Supervising and approving the manner of disposing of patent rights by the individual departments, including granting exclusive licences and selling Government-owned patents.
 - (b) Instructing and advising departments and agencies, collecting information, conducting investigations and making appropriate recommendations.
 - (c) Promulgating general policies and supervising and approving departmental policies regarding employee inventions and determining disputed cases.
4. Among the other interesting conclusions arrived at by the Commission may be mentioned its approval of the proposal that employee inventors should be granted special awards for unusually meritorious services. The Commission recommends that Government agencies interested in an award system should be authorized independently to make individual awards up to a specified amount ; awards above this amount and up to a specified maximum should be approved by the central control body.

R. B. PAI

REVIEWS

Tinplate. By W. E. HOARE and E. S. HEDGES (Edward Arnold & Co., 41 and 43, Maddox Street, W.1, London), 1945. Pp. viii+292. Price 40s.

IN producing their admirable monograph *Tinplate*, Messrs. W. E. Hoare and E. S. Hedges have made a notable contribution to technical literature, which will be of interest and value equally to manufacturers and users of that exceedingly useful commodity. As the authors remark in their preface, a complete and balanced account covering manufacture, properties and uses of tinplate has hitherto been wanting.

From the manufacturing angle, the book is particularly timely in view of the revolutionary developments of recent years. In the United States of America, the time-honoured method of producing the steel base for tinplate from a half-inch thick bar by hand rolling in packs has now entirely disappeared, and in its place a hot strip mill in one continuous operation reduces a four or five inch slab to 100 yards or more of thin strip, which is then passed on to another heavy duty mill which further reduces the thickness of the strip by rolling it cold down to tinplate gauges. Finally the exigencies of war have given great impetus to the advancement of electrolytic tinning, whereby the tin coating can be imparted to the steel base while still in the form of strip and much thinner coatings can be applied than is possible with the normal hot dipping of single sheets.

Although it seems clear that the hot strip and cold reduction mills will rapidly supersede the hot pack rolling process in European countries, as they have done in America, we are inclined to the view that the Indian industry should be in no hurry to follow suit. Generally speaking, highly complicated labour-saving machines cannot be operated so efficiently here as in Western countries, nor is there the need for them so long as moderately skilled labour is readily available at comparatively low cost. Again, the enormous output of the hot strip mill is a factor to be reckoned with and possibly a compromise between the fully automatic mill and the hand rolling

system will be found to be best adapted to Indian conditions. This, however, is a digression on a subject outside the scope of the book, which is confined strictly to matters of established practice.

The authors have handled their material skilfully, not overloading the text with excess of detail, but providing ample documentary references to facilitate study in greater detail. The illustrations, both photographic and diagrammatic, are excellent, while the statistical appendix and double index (subject and author) are features in keeping with the general excellence and thoroughness of the work.

J. P. A.

Handloom Weaving Industry. By Mr. M. P. GANDHI (Gandhi & Co., Jan Mansion, Sir P. Mehta Road, Bombay), 1945. Pp. 32. Price Re 1.

Mr. M. P. Gandhi's publication, entitled *Handloom Weaving Industry in India* published in June 1945, is a review of the report of the Fact Finding Committee (Handlooms and Mills) published by the Government of India. The committee was constituted by the Government of India in the Commerce Department on 25th January 1941 and the terms of reference were :

The problem of safeguarding the position of the handloom industry and at the same time, reconciling the conflicting interests of the handloom and mill industries... etc.

In Mr. Gandhi's publication, he has, *in extenso*, quoted various terms of reference of the Committee and the work done by them and has, more or less, abridged the facts contained in the various chapters of the published report. Some of the conclusions of the Fact Finding Committee report are amplified.

The publication is handy and puts before the public in a masterly way all the facts contained in the Report on handloom weaving industry. It is well worth close study by all those interested, who cannot find the time to go through the original voluminous report. For a full appreciation of the situation, however, a close study of the

Fact Finding Committee report, in original, would prove valuable.

Mr. M. P. Gandhi has come to the conclusion that the handloom weaving industry in India has shared the general prosperity of the textile industry during the war period, 1939-45. The facts, however, are otherwise. While large-scale mill industry made very rapid strides during the war, the industry almost doubling its production, building up huge reserves for future replenishment of machinery, declaring high dividends to the investors and paying higher rates of wages for the labour engaged, the condition of the handloom weaving industry is very depressing indeed. It is with considerable difficulty that the handloom weaving industry was able to maintain its pre-war position. It should be appreciated that just before the war broke out, the condition of the handloom weaver was none too good. The circumstances which prevailed then and the serious unemployment that did exist in the handloom weaving industry have all been elaborated in the report of the Fact Finding Committee. The total volume of handloom goods even towards the end of the war was not larger than what it was in 1939 and, in fact, the estimated production was even lower. Mr. Gandhi has in his preface, drawn attention to this fact and states that after 1944, the situation improved. With regard to the supply of raw material, i.e., cotton yarn to the handloom weavers, it may be stated that after 1944, efforts were made to assure the handloom weaver the same quota of yarn as was available to him in the past based on the actual consumption of yarn in 1939-40, as per the findings of the Fact Finding Committee. While every effort was made by the Textile Commissioner, Government of India, to improve the situation, on account of the various practical difficulties both regarding transport and distribution of the yarn, there was considerable maldistribution of the raw material and the handloom weavers in various important producing centres, particularly those that were situated in the interior places, suffered considerably. Their distress was, and still is, very acute in so far as they are not yet in a position to secure all the yarn that is necessary to keep their looms going all the year round. The situation with regard to the inadequate supply of yarn of suitable quality and at competitive prices which would allow

the handloom weaver to produce fabrics and yet be in a position to compete with similar fabrics produced in the mills, is a problem of vital importance, on the remedying of which, the well-being of the handloom weaving industry mainly depends.

As has been pointed out by Mr. M. P. Gandhi, the All-India Handloom Board has come into existence, and it is hoped that the Board would tackle the vital problems connected with the welfare of the industry and solve them to the satisfaction of the handloom weaver so that the age-long and most important cottage industry will be allowed not only to survive but to prosper side by side with the mill industry in India. There is certainly great scope for increasing the output of textile goods both in mills and handlooms to meet the requirements of the 400 millions in India. In planning to meet the requirements for the textile goods, it is necessary to give high priority for handloom goods. An industry which provides employment for ten million people cannot be lightly brushed aside. Favourable conditions should be created to ensure its future prosperity.

B. K. MURTHY.

Symposium on Analytical Colorimetry and Photometry. Sponsored by A. S. T. M. Committees E-2 and E-3. (American Society for Testing Materials, Philadelphia, Pa.). 1944. Pp. 75. Price \$1.00.

Sponsored by two active committees of the *American Society for Testing Materials*, namely, Committees E-2 on Spectrographic Analysis, and E-3 on Chemical Analysis of Metals, this symposium presents a series of discussions by leading authorities under two pertinent topics—Instrumental Section and Chemical Section. The authors cover some of the more recent improvements in apparatus for measuring the absorption of light by aqueous solutions, development of superior methods of test based on the use of such apparatus, and use of photometric methods in analytical chemistry. The symposium covers both the theoretical and practical aspects.

Topics covered in the Instrumental Section include: Trends in Analytical Chemistry—B. L. Clarke; Colorimetric Analysis and Beer's Law—J. L. Hague; Filter Photometers—A. E. Ruehle; Glass Photometric Filters—O. A. Gage; and Spectrophotometers—K. S. Gibson.

Under the Chemical Section are numerous methods which have been developed, prefaced by two very interesting and valuable reports, one by M. G. Mellon on Chemistry in Colorimetry, and the second, an extensive bibliography of 200 references on Colorimetric Methods by J. W. Stillman. Numerous methods are detailed relating to Aluminium-Base Alloys—J. J. Stumm ; Magnesium-Base Alloys—V. A. Strenger ; Other Non-Ferrous Alloys—C. Zischkau ; and Ferrous Alloys—Arba Thomas.

The importance of disseminating information on new techniques of analysis is too obvious to need emphasis. In his opening remarks at the symposium Dr. G. E. F. Lundell says :—

“The enormous number of determinations demanded and the time allowed for them, threatened completely to swamp chemical analysis. From the analyst's search for simpler and more rapid methods have come physical methods, such as emission spectrographic, and chemico-physical methods, such as potentiometric, that require little or no chemical treatment. The rapid improvement within recent years, of apparatus for measuring the absorption of light by aqueous solutions, and the development of superior methods of test based on the use of such apparatus, have led to a constantly increasing use of photometric methods in analytical chemistry. . . .”

The symposium is illustrative of current trends in analytical chemistry. A radical departure in the methods of training analysts—from the classical volumetric and gravimetric procedures to instrumental methods—is called for, and a study of the booklet gives a clear indication of the kind of training and experience that an analyst should have in order that he may devise and adopt techniques and apparatus which permit accurate analysis of ferrous and non-ferrous metallic systems.

Salt—Its Sources and Supplies in India.

By KAPILRAM H. VAKIL (The Commercial Printing Press, 105, Cowasji Patel Street, Bombay), 1945.

Mr. Vakil, the well-known authority on the manufacture of salt, is the author of other important publications on allied subjects, such as “Salt” and “Marine Minerals,” and is the most competent person to write the book under review. In the preface to this monograph, the author mentions that it has been written for the Dictionary of Economic Products and Industrial Resources of India, a new publication in preparation by the Council of Scientific and Industrial Research, and is now published with the

approval of the authorities for public information. He has given in this book, complete information about the places of manufacture of salt, both from mineral and marine sources, in India and the analyses of the salt obtained, and the average amount produced per year during 1926-36 and in 1935-36 from these sources. He has also given the cost of production of salt as well as the territorial distribution of the salt manufactured at various centres of production. Mr. Vakil has to be credited for collecting and publishing this data which provides authentic information on the manufacture and distribution of salt in India—information which is of great importance both to scientific men and to the general public.

A table at the end of the monograph gives the amount of foreign salt imported into Calcutta and Chittagong, mainly from Aden, Port Said and other sources. It shows that this amounted to 90 per cent. of the salt imported in 1929-30, that is, 596,819 tons, and came down to 227,930 tons and 230,571 tons respectively in 1942-43 and 1943-44. Mr. Vakil is of the opinion that there would be no need for importing foreign salt into India, if the salt industry is well organized ; the amount manufactured will not only meet India's demand but could also be exported to neighbouring countries.

A review of the cost of production of salt from various sources shows a great disparity. While it is manufactured at As. 8 per ton from Sambhar Lake, the cost rises up to Rs. 2-5-10 from Northern Indian sources.

Mr. Vakil has taken great pains to work out the *per capita* consumption of salt in various places in India. It varies from about 9 lbs. to 14 lbs. per annum, the average consumption over the entire population in India being 13 lbs. *per capita*. He has explained the variation on the basis of the diet and habits of people in the several Provinces ; in places where meat and wheat form the principal food, the salt consumption is low.

Owing to the limited scope of the book, the author has not given in detail the history of production of salt in India and the technical details of the salt industry. A monograph on the manufacture of pure salt required for various industries is a great necessity, and it is hoped that Mr. Vakil will find time some day to bring out such a publication.

M. P.

SCIENTIFIC RESEARCH ON INDIAN RAILWAYS*

By D. R. MALHOTRA

THE Railway's main requirements are coal, water, metals and oils on which approximately a sum of Rs. 30 crores are spent annually.

Fuel

The coal used on Indian railways is about $8\frac{1}{2}$ to 10 million tons a year, which approximates to one-third of the total coal raising capacity of India.

According to the report of Illinois University, about one-fifth of the fuel is used at periods when the locomotive is not doing any useful work, i.e., in firing up, waiting for trains, standing on sidings, delays at terminals and waiting at ash pits. The remaining four-fifths is used for hauling trains. Out of the latter, 70 per cent. is applied for raising steam and the rest goes to waste as hot gases, cinders, unburnt gases, etc. Out of the 70 per cent. again, 5 per cent. is lost by radiation, 6 per cent. in air pumps and blowers and the remaining 50 per cent. goes to the cylinders. 52 per cent. of what goes to the cylinders passes out as exhaust steam, leaving 7 per cent. only for work at the draw-bar and even out of this 1 per cent. is used up in overcoming the friction. So, any effort made in this country to reduce these losses even by one per cent. would show a saving of 100,000 tons of coal per year, equivalent to Rs. 20 lakhs. To conserve the coal resources of the country, the following measures are suggested :—

- (i) *Blending of Coals.*—To conserve the high quality coal, a certain percentage, say upto 20 per cent. of inferior coal (high ash content) may be mixed with the superior coal. In this connection, various proprietary materials are suggested for use along with inferior coals, but in the opinion of the speaker, the use of oil sludge or used mineral oil would be more advantageous, as it not only reduces the loss of fine coal cinders but also diminishes clinkering by promoting more thorough combustion.
- (ii) *Briquetting.*—It is well known that a great amount of coal slack or dust is produced at the collieries as well as in the course of transit. A suitable and cheap method may be evolved for making briquettes from the slack and dust.
- (iii) *Hydrogenation.*—The conversion of coal into oil has been known for a considerable time, but in India very little work appears to have been done on high pressure hydrogenation of coal. It is a subject for scientific research, and the attention of the *Board of Scientific and Industrial Research* may be drawn to it.
- (iv) *Diesel Locomotives.*—Compared with steam locomotives, the Diesel is a far better mechanical unit with regard to its efficiency, its usual rating being in the region of 80 per cent. of the calorific value of the fuel consumed. Weight for weight, Diesel oil gives six times the useful heat given by coal. One lb. of oil equals 8 lbs. of coal in power output,

and assuming that it is four times costlier than coal, the running cost using oil would be still 50 per cent. cheaper. At places far removed from the collieries, Diesel traction has a wide field for investigation.

Water

Scaling, corrosion and priming are the three main troubles that are generally met with in all boiler waters on the railway. Indian railways have been quite alive to the necessity of softening water, and to-day there are 98 plants erected at a total cost of Rs. 23 lakhs with a recurring cost of about Rs. 1 lakh per month, functioning at various places. Out of the 12,000 million gallons of water used annually by the locomotives of the Indian railways, only 1,400 million gallons are softened at present.

The Inglis-Appleton Mission in 1944 recommended the extension of water softening of Indian railways. Mr. J. S. Hancock of the London Midland and Scottish Railway was invited by the Railway Board in January 1945 to give his expert advice on the subject of water softening and the speaker was associated with him in this investigation. Practically all the railway workshops in India were visited, and the information obtained was not sufficiently convincing to enable them to advise the Government to spend huge amounts of money on water-softening plants without obtaining reliable data on the conditions which lead to priming, and on the financial loss caused by the scale-forming matter entering the boiler. It was, therefore, recommended that the Railway Board should set up a research organization to establish a basis on which the financial savings resulting from water softening could be calculated. The speaker has produced a formula—the *I.R.C.A.* formula—from the results of experiments carried out on the B. B. & C. I. Railway. Applying this formula, it has been calculated that the damaging effect of the scale-forming matter entering the boiler varies between As. 5 and Re. 1-2 per lb. This work is in no way complete and proper research should be instituted on the whole problem of water softening.

The intensive use of blowdown in conjunction with the water-softening plants is highly desirable, but its limit should be very carefully controlled. In view of the importance of this subject, it is essential that extensive research should be undertaken to establish critical priming concentrations in different types of railway boilers in India. In order to get a firsthand experience of water-softening problems, and also in view of the fact that the Railway Board has under consideration a scheme for the erection of 445 new plants, it is imperative that Indian railways should send a committee of experienced engineers to the U.K., U.S.A. and South America.

It may be of interest to note that the *Permutit Co.* in England has developed a new process for the demineralization of water. Even sea water can be rendered potable by this process. It is suggested that some experiments should be undertaken on Indian railways to see if this process could be economically adapted in India.

* A brief summary of the address delivered by Dr. D. R. Malhotra, Chemist and Metallurgist, B. B. & C. I. Railway, under the auspices of the Central India centre of the *Institution of Engineers (India)*, New Delhi, on 21st September 1945, with Sir Lakshminipati Misra, B.E., M.I.E. (India), Chief Commissioner of Railways, in the chair.

Metals

The total value of metals purchased by Indian railways amounted to Rs. 26 million in 1943. Permanent-way material, i.e., rails, fishplates and metal sleepers amount to Rs. 10 million. It has been established that medium manganese steel is much superior to plain carbon steel for rails, and the British railways have, therefore, adopted a specification with manganese from 0.9—1.2 per cent. The medium manganese rails can be improved upon for wear resistance by treatment with Sandberg sorbitic process.

The heat treatment of points and crossings is a matter of great importance. It has been stated that 50 per cent. of the total cost spent by the railways on permanent way is on joint maintenance and upkeep. This could be considerably reduced by the welding of rails. The importance of this has been strongly emphasized by the Wedgwood Commission. It must be said that the welding technique and the type of electrodes employed are important for obtaining a proper weld. The two principal welding processes followed in India are electric butt welding and thermite welding.

It should be regretted that although Indian railways have a large number of melting units all over the country, not a single workshop has so far been equipped with adequate facilities for testing foundry moulding sands. It is needless to say that even the finest and best quality metal can be spoiled by faulty moulds and hundreds of tons of metal are thrown to waste for want of adequate knowledge relating to moulds, such as the correct proportion of Indian bentonite to be mixed with silica sand in order to secure proper refractoriness, strength and bonding properties.

As a result of research conducted at Ajmer and Lahore, it has been found possible to produce high duty cast iron by controlling the melting technique. A great deal remains to be done to standardize the conditions which will ensure castings of a uniform and standard quality. The new locomotive manufacturing scheme in India involves large amount of steel castings and it is essential that up-to-date metallurgical equipment for manufacturing steel suitable for railway requirements should be obtained.

Coming to the non-ferrous foundry, excepting a few railways, the melting technique, in general, is crude and obsolete. Indian railways use approximately 6,000 tons of non-ferrous metals per year valued at more than half a crore of rupees. It is surprising to know that no metallurgical research worth mentioning is being carried out to improve the quality of known alloys or to develop new ones. The laboratories in the Indian railways are poorly equipped and there are hardly any facilities for research. At a recent meeting of the Non-ferrous Metals Panel, the problem of disposal of non-ferrous melting furnaces and other equipment

available in ordnance factories was considered. It would be useful if the Railway Board deputed some metallurgists to examine the equipment with a view to purchasing the same. Experimental work should be undertaken to refine the scrap available for railway use.

Radiographic equipment should be obtained for testing internal flaws of metals and alloys without destructive tests. It is understood that one of the ordnance factories in India has a modern X-ray plant. The Railway Board should purchase the equipment for their laboratories.

Use of Light Metal Alloys

The coming age is the age of light metals, and aluminium is destined to play an important role in the future development of industry. Complete train and coaches have been built from aluminium alloys in America. The increased demand for comfort and for higher speeds has resulted in an increase in the use of aluminium alloys. The use of light alloys has considerably reduced wear and tear.

Aluminium cables will be a rival to copper in bare wire transmission of electricity. For the past 15 years, aluminium alloys are finding innumerable uses in the engineering industry including the construction of bridges. The immediate demand from the Indian railways for light metals would be for windows, sliding doors, partitions, seat frames and internal fittings, but it is certain that when the aluminium industry is firmly established in this country, the Indian railways would utilize the light metal alloys in considerable quantities.

Lubricating Oils

Indian railways use about 3 million gallons of lubricating oils per year. Most of the oil is thrown away to waste after use for want of suitable refining equipment. The refining of lubricating oils for reuse demands investigation.

The latest development in the field of hot boxes is to employ oilless bearings. The fabrication of such bearings has been rendered possible by developments in powder metallurgy. There are vast possibilities for employing the new technique which makes it possible to incorporate in one body, metals of different melting points.

The Indian railways should have a central research laboratory to investigate the large number of problems connected with the railways. In addition, the Railway Board should have a Directorate to deal with problems connected with fuel, water, oil and metals—the four important items used by the railways on which some two crores of rupees are spent every month. Even a fraction of the savings resulting by the application of technical research would suffice to finance a well equipped and adequately staffed research establishment.

NOTES AND NEWS

THE utilization of boron in steel has been under investigation for nearly 40 years. Initial studies, however, were concerned with percentages of this element which, although small, produced a steel that was found to be unworkable due to hot-shortness. Eventually these investigations were abandoned. In more recent years, the work was revived, but on a different basis, the amount of boron being drastically reduced to tiny fractional percentages. The results were most gratifying; as little as 0.0006 per cent. of boron produced a distinct increase in the hardenability of steel. The most advantageous proportions were found to be around 0.0002 per cent. If this is much increased, hot-shortness begins to appear, and if further increased, the metal becomes so hot-short that it is unworkable.

It appears that boron acts very much like some of the other elements (such as manganese, chromium, nickel, molybdenum, etc.) which are used in the alloy steels to increase hardenability. (We are speaking of hardenability, not hardness; we are thus concerned only with the depth to which a steel is capable of hardening when quenched). The principal difference between boron and other alloying elements is that boron seems to have a greater effect, which forces the steel-maker to use exceptionally small proportions, and these small proportions, in turn, require exceptional care to insure equal distribution throughout the metal. Because of such conditions, its introduction in the form of a "master alloy" is even more essential with boron than with some of the better known alloying elements. Several metallurgical firms are marketing boron-content master alloys for steel-makers, and some mills are now producing boron-content steel.—*Machinery*, July 1945, *U.S.I.S., Min. and Met. Eng. News Letter*, No. 12.

Iron Ore Concentration by Flotation

In view of the ultimate depletion in the United States of the high grade Lake Superior ores, and the need for beneficiating those of lower grades which are in such abundance, significance is attached to a recent patent for froth flotation methods of concentrating ores. This patent describes methods of concentrating finely divided oxidized iron ores in which the gangue ingredient is principally quartz. This consists in treating an aqueous pulp of such an ore with an anionic collecting agent. Included in suitable agents for this purpose are the soaps of high fatty acids or of resin acids. Co-operating agents, like lime and acid-treated starch solutions, are also used. Ore pulp thus treated is subject to froth flotation and the silica-containing froth is removed, thereby producing in the pulp residue a concentrate rich in iron oxide.—*The Iron Age*, 1945, July 12, *U.S.I.S., Mining and Met. Eng., News Letter*, No. 12.

Berseem, A Valuable Fodder and Manure

Berseem has been found to be an excellent fodder, especially for milch cattle, and a valuable green manure. It is one of the principal fodder and green manure crops in Egypt and was introduced in India in 1904.

An effort has since been made for its extensive cultivation, but the failure of the crop to set seeds in certain parts of India has prevented its further spread. Investigations were started at the *Imperial Agricultural Research Institute* at Delhi and its sub-station at Pusa, with a view to finding a solution of the problem.

The results obtained have shown that pollination by bees is an essential requirement for seed setting in *berseem*. The bee population in the field was augmented during April when the crop is in flower. It was, however, noticed that probably due to heat, bees were active only for a few hours in the early morning and late evening to the detriment of efficient pollination. In March there is a larger number of bees in the field and the temperature is very congenial for their activity. If the *berseem* crop could be made to flower earlier, i.e., in March, a good set of seeds may be obtained. This possibility is under investigation.

Insecticides from Indigenous Materials

It may be possible to utilize opium marc, a waste product left over after the extraction of pure opium, as a cheap insecticide. Owing to the high cost of imported insecticides, investigations were carried out at the *Imperial Agricultural Research Institute* to find out if they could be produced from indigenous materials, particularly of vegetable origin. Opium and tobacco were taken up for study. Dilute acetic extracts of opium marc proved effective as contact poison.

Forty-two varieties of Indian tobacco were taken up for ascertaining their germicidal value. Samples from leaves, stalks and branches were selected. The results obtained indicated a high correlation between insecticidal value and nicotine content.

Iron Pentacarbonyl as Anti-knock Agent

Iron pentacarbonyl is an effective antiknock agent for ethyl alcohol fuels. (The term "ethyl alcohol" is used here in the chemical sense, and is equivalent to anhydrous ethyl alcohol.) However, caution must be observed when it is used in motor fuels, since the iron oxide deposit may seriously interfere with engine operation. The action of light changes iron pentacarbonyl to iron enneacarbonyl which is practically insoluble in hydrocarbon fuels. Iron enneacarbonyl, however, is soluble in ethyl alcohol, at least to the extent tested, and no obnoxious precipitate occurs in this fuel. Small amounts of oleic, palmitic, and stearic acids and of triethanolamine oleate are effective stabilizers for the iron pentacarbonyl in some hydrocarbon fuels; however, no generalization can be made at present. For solutions in anhydrous ethyl alcohol and in ethyl alcohol containing 5 per cent. water by volume, no stabilizer is necessary. If reasonable precautions are observed, working iron pentacarbonyl is probably no more dangerous from a health standpoint than tetraethyllead.—*Ind. & Eng. Chem., Ind. Edn.*, June 1945, *U.S.I.S.*

Dielectric-Heating Laboratory

Dielectric heating heats materials internally and uniformly, not from the outside in, as in the oven method. This is done by passing alternating current at extremely high frequencies through materials such as wood, plastics and even food and oils, which are poor conductors of electricity. A principal use now is in laminated materials such as propellers and plywood sections. But its scope extends to many applications in drying or curing processes in food, plastics, fine woods, ceramic materials and in many cases where uneven or high outside temperatures cannot be used. The basic principles of dielectric heating and new industrial uses are being studied at a special research centre recently established at Columbia University, New York City. This laboratory converts 60-cycle current to as high as 30,000,000 cycles.

Experiments with granular materials showed that substances formed of large particles heat faster than those of smaller size. This might be applied in some industrial processes to heating catalyst beds, bringing such masses of particles up to their reaction temperature more quickly and uniformly than through usual methods. Because it heats uniformly, lower temperatures can be used in dielectric heating. Food oils have been dried at the Columbia laboratory at temperatures below the boiling point of water, thus avoiding damage to the oils. Dehydration of food while safeguarding nutritional values and drying timber for fine lumber are other indicated applications but the dielectric process "can be used for anything, which cannot stand high temperature at one point in order to get heat to another point."

Dielectric heating also can be used as a tool in investigating the structure and chemical make-up of coal. In the usual methods of making coke from coal, there are differences of temperature throughout the process. But dielectric heating, maintaining the same temperature throughout, can be used to determine at what specific temperatures the various volatile constituents of the coal are released, thus adding to information concerning the make-up of coal.

The laboratory also plans experiments using frequencies higher than 30,000,000 cycles to permit applications with more kinds of materials. An example is curing or drying operations on thin sections of materials, in which electrodes must be closely spaced, with risk of breakdown if the voltage is high. But higher frequencies require less voltage, reducing this danger.—*U.S.I.S., Chemical, Engineering and Chemistry News Letter*, No. 13, 1945.

Ceria Abrasives

Ceria has been developed, as an abrasive for polishing optical glass by *Research Enterprises, Ltd., Toronto*, and has proved highly satisfactory, especially on account of its extreme insolubility and cleanliness. At present its cost is considerably greater than that of rouge, but a little goes a very long way.—*Chem. Age*, 1945, 53, 252.

Calcium Chloride in Tyres

Solutions of calcium chloride can be used to fill heavy-duty truck, tractor and farm implement tyres. This development is being pushed by certain equipment builders because it gives better traction with less tyre wear than is possible when air is the filling

medium. Loss of inflation and excessive wear when operating tyres not fully inflated are also troubles that are avoided.—*Chem. and Met. Eng.*, Apr. 1945.

Safety Fuel

A new safety fuel for aircraft, so resistant to accidental ignition that a lighted match can be dropped in without causing a fire, has been announced and its properties demonstrated in New York to a group of scientists. It has all the power of 100 octane fuel, extended tests in a high-powered airplane engine show. The new safety fuel is a development of the *Standard Oil Company* of New Jersey, and the demonstration was made by technical men of that *Company* and of *Pan-American World Airways*. The chief engineer of the latter company pronounced it to be "an important technical advance in aviation." The safety feature of the new fuel is due to the fact that it does not form inflammable vapours in the air in great enough quantities to ignite, unless it is at temperatures above 100° F. Ordinary motor and aircraft gasolines do, and they ignite readily and burn rapidly because of the vapours formed. The new fuel, however, must be fed into the engine by direct injection rather than by ordinary carburetion such as is used with conventional gasolines. Unless suitable carburetors are developed, engines now in use will have to be converted for fuel injection if the new fuel is to be used. After the fuel is injected into the cylinder, it is vaporized by the heat developed during compression. The fuel mixture is fired by the conventional spark plug.—*Science*, 1945.

Mobile Power Plants

That unit transportable electrical power plants, complete with generator, steam turbine, boiler and other necessary parts, are being shipped to Europe to furnish power in bombed-out regions to help the return to normal industrial production, is announced by William E. Knox of the *Westinghouse Electric International Company*. The units are of two sizes, one with a capacity of 2,000 kilowatts, the other half as large. The idea of a compact power-producing unit was first conceived by Mr. Knox for use in China following a trip to that country in 1939. The Chinese, forced back into the interior by the Japanese from their coastal industrial cities, needed a quick means of generating electric power for war production. *Westinghouse* designed units that could operate on locally abundant low-grade coal and models that were built to burn lignite, oil, wood and even peat. The European war created another demand. A semi-portable design was perfected that could be assembled in a minimum of time. To meet the emergency requirements or rehabilitation, a design was made that simplifies the arrangement of the major parts and eliminates all dispensable refinements.—*Science*, 1945, 102, Suppt. Aug. 3, p. 10.

A Novel Form of Refrigerator

When a gas is allowed to flow out along the radius in a rapidly rotating enclosure, it is compressed and, therefore, heated. The enclosure may be supplied with a coil of pipe carrying a cooling liquid to remove the heat of compression as formed in the gas. On guiding the gas back to the axis, it is cooled by its own expansion and a maximum ΔT of about 150° C. occurs. The work of expansion is determined by the rotor demand, not by the gas temperature or by the gas volume change. Both warm and cold fluids enter

and leave the enclosure axially. Analysis shows that the cooling, ΔT , is given by $\frac{w^2 r^2}{2c}$. The rotational energy of the enclosure is not drawn upon by the steady fluid flows. The cooling liquid moves convectively through its circuit but the gas must enter the enclosure at a pressure somewhat above that at exit.

Maximum peripheral speeds allow 19 cal./gram to be extracted from the gas flow giving for air a drop of 77° C. from room temperature. This is more than sufficient for most commercial refrigeration. Use of a favourable gas in the rotor gives sufficient ΔT to be very effective in gas liquefaction. Rotors may have their flows in series to increase the ΔT , and the gas may be at a supercritical pressure to keep it homogeneous till released from the pressure. The device is expected to have high efficiency as a refrigerator. By utilizing the rejected heat, as Kelvin suggested, the device may be used for domestic heating—*J. App. Physics*, May 1945; *Physics News Letter*, No. 32.

Dyes Aid Solar Evaporation of Brines

One of the industrial uses of dyes is in the acceleration of the solar evaporation of brines for the recovery of salt. According to the Annual Report of the *Imperial Institute* (1944), the German patent covering the Block and Martin process, relates to the use of naphthol green or other dark coloured dyes capable of absorbing light of wave lengths upto 8,000 Å.

Production of Cinchona in India

There was a large extension of acreage under cinchona during the year 1944-45, states the Report of the Principal Quinine Officer, Government of India, on cinchona and quinine for that year. The Government of Madras worked to a programme of 1,000 acres and the Government of Bengal 400 acres. Most of these areas were close planted with a view to obtaining an early crop.

1,01,419 lbs. quinine sulphate and 62,355 lbs. of cinchona febrifuge were added, mainly due to production by the Governments of Bengal and Madras, to the total stocks, and 1,27,803 lbs. quinine sulphate and 43,169 lbs. cinchona febrifuge were issued during the year, the balance of stock on 31st March 1945 being 2,05,454 lbs. quinine sulphate and 1,03,352 lbs. cinchona febrifuge.

There was also a certain revival of interest in cinchona amongst the planters. One tea estate in Assam has grown cinchona in the plains and this, if successful, may have far-reaching possibilities. In Government plantations and in one of the private estates in the south, work is being done on vegetative methods of production. These are likely to contribute materially to a reduction in the cost of production in future.

Aerial Photography to Aid Geological Survey

Aerial photographs will in future be used to aid the *Geological Survey of India* in its quest for underground wealth.

Large-scale detailed mapping, which is the basic function of *Geological Survey*, will be extended to individual mines and specific areas to discover new deposits. The future life of the Bihar Mica belt, for example, may well depend upon such a survey.

Study of glaciers and earthquakes, river surveys and soil investigations which will be conducted by

the *Survey* are bound to benefit a number of Departments like Forests, Agriculture, Irrigation and Public Works.

Geophysical methods, successfully adopted in the more advanced countries of the West, will also be increasingly employed in unearthing the hidden mineral wealth.

Tests for Quality Control

An interesting article in the current *Pipe Progress*, house organ of the American Cast Iron Pipe Co., stresses the extensive work required in maintaining quality control. For example, it is indicated that in chemical analysis, involving not only melts and the finished products, but samples of raw materials as well, such as ferro-alloys, an average day's work might include the following number of determinations.

Silicon	.. 41	Nickel	.. 1
Sulphur	.. 68	Molybdenum	.. 2
Manganese	.. 32		
Phosphorus	.. 45	Chromium	.. 2
Carbon	.. 62	Copper	.. 2

In the physical laboratory where all kinds of tests are necessary—hardness, tensile, etching, impact, etc.—the daily number is well over 100 and periodically a complete pipe bursting test is carried out. Sand for molds and cores must be checked; also tars and other material used. Some of the methods have been speeded up, of course—carbon, for example, where a rapid combustion method will give results in five minutes from time of pouring—and a spectrograph is used to check products containing alloys, etc. The latter might run around 200 determinations daily.—*A.S.T.M. Bull.*, 1945, No. 135, p. 51.

Steel Research in U.K.

As a logical sequel to the steel industry's Five-Year Plan to spend £120,000,000 (see *Chemical Age*, July 28) is the decision to form a new central research association in London, to be called the *British Iron and Steel Research Association*. Its annual revenue will total about £400,000 of which £250,000 is to be contributed by the industry, while the balance will be met by a grant from the *D.S.I.R.* and from other sources. At the head of the new formation will be Dr. C. F. Goodeve, F.R.S.

The new Principal has explained that valuable work has been done by the laboratories of the country's steel makers, and by the *Iron and Steel Institute*, as well as by the *Iron and Steel Federation's Research Council*, but the new association's task will consist in co-operative research and exchange of information on a much wider basis, working with such research organizations as study raw materials, particularly coal and plant design. It will establish more intimate contacts between the producers and the users, such as the railways, shipbuilders, and engineers. The industry's own research organization would work in conjunction with the universities, and teams were already active in Cambridge, Sheffield, Newcastle, London, Birmingham, Swansea, and Glasgow. At the works of member firms full-scale development work would be put in hand.

It is understood that one aspect of the work will concentrate on problems connected with coke and refractories, while another branch will be devoted to the use of poor quality British ores; a special division will study the important and frequently underestimated subject of design and layout, with a large research programme on alloys.

The association will have its own laboratories with more elaborate equipment than those of individual firms, and an interchange of experts with overseas countries is planned. This research programme which is intimately connected with the modernization plan of the industry should make it possible for the British iron and steel industry to regain that leading position which was, during the last two or three decades, lost to foreign steel makers.—*Chem. Age*, 1945, Aug. 4, Met. Section, Page 105.

Penicillin Research Fund

Fifteen U.S. penicillin producers have completed the research fund pledged to Sir Alexander Fleming on the occasion of the dinner in his honour in New York on 25th June. The fund, which is to be known as the Alexander Fleming Fund, amounting to more than £20,000, will be placed in a Trust, and the income and principal will be devoted to scientific research under the direction of Sir Alexander Fleming at St. Mary's Hospital Medical School, University of London. Sir Alexander is being given the widest latitude in the use of the Fund for scientific purposes, and the results of the research will be free for use by anyone with no restrictions whatsoever. The University of Pennsylvania is to administer the Fund.—*Chem. Age*, 1945, 53, 248.

A Permanent Standards Organization

The Executive Committee of the United Nations Standards Co-ordinating Committee, after an extensive survey of present conditions in the field of international standards and the rapidly changing events on the international scene, has come to the conclusion that the time is now ripe for setting up a permanent standards organization. The Executive Committee consists of the British Standards Institution, the Canadian Standards Association and the American Standards Association.

Invitations to attend the meeting have been sent out to the national standardizing bodies comprising the United Nations Standards Co-ordinating Committee. These are:

The Standards Association of Australia, Associação Brasileira de Normas Técnicas, The Canadian Standards Association, The Chinese Standards Committee, The Association Française de Normalisation, The British Standards Institution, The New Zealand Standards Institute, The South African Standards Institution, The American Standards Association.

It is anticipated that representatives from practically all the countries will attend.

A full programme of the detailed discussions to be undertaken at the meeting will be announced at an early date. In a general way, however, it can be said that the meeting will concern itself with the immediate problem of establishing the closest practical relations between the national standardizing bodies of the countries of the world, with providing a forum through which these bodies can harmonize their activities internationally, and finally the meeting will deal with the major problem of integrating national standards and harmonizing them for the benefit of the total economy of the world.—*Science* 1945, 102, 191.

Indian School of Mines

Proposals for the reorganization of the *Indian School of Mines, Dhanbad*, it is understood, will shortly be considered by a committee constituted by the Labour Department of the Government of

India. Mr. D. L. Mazumdar, Joint Secretary, Labour Department, will be the Chairman of the Committee and Dr. D. N. Wadia, Mineral Adviser, Planning and Development, and Dr. S. R. Sen Gupta, Assistant Education Adviser (Technical), Education Department, will be its members. The Committee may, if necessary, co-opt one or two additional members.

The objects underlying the proposals are the expansion of the activities of the *Indian School of Mines* and the provision of adequate facilities for the training of a larger number of students on a standard approaching that of the *Royal School of Mines* in the *Imperial College of Sciences and Technology, South Kensington, U.K.* The *Indian School of Mines* has been so far able to train only 24 students annually, but the demand for trained men in mining and geology is steadily increasing.

Technological Research in Cotton

"A new spinning technique has been developed by means of which a 2-lb. sample can be spun yielding results comparable with the normal samples," states the Annual Report of the Director, Technological Laboratory, Bombay, for the year ended 31st, May, 1945, published by the Indian Central Cotton Committee, Bombay.

New formulas have been evolved which give a better prediction of the spinning value of Indian cottons from fibre-properties.

A new apparatus useful for measuring the diameter of fine wires, hair, wool fibres, artificial silk filaments, cotton lint, etc., has been designed and fabricated.

There was an increase in the number of samples received for tests during the year under report, the figures for 1944 and 1945 being 1,514 and 1,685 respectively. Fibre tests on flat strips and fly obtained by placing the stripping-comb on the licker-in side showed that they have a higher percentage of short and lower of long fibres than when the comb is placed as in the ordinary process. Tests on combing of good quality Indian cottons revealed that after combing to the extent of 16—18 per cent. some of them yielded yarns which are comparable in strength to Kampala carded yarns. Experiments with different front roller speeds of the draw frame were also carried out. It was found that the highest speed (525 r.p.m.) gave the best test for long staple cottons, intermediate speed (475 r.p.m.) for medium staple cottons and the lowest speed (375 r.p.m.) for the short staple cottons. Since some difficulty had been experienced by ginners with the Buri cotton, experiments were made with different sizes of grid. A grid of either 6/16" or 7/16" with an overlap of 3/16" in a single roller gin yielded the best results. Tests were also made on samples received from foreign countries like Uganda, Belgian Congo, etc., whose cottons are used in Indian mills.

Several Indian States in which cotton is grown on a big scale took advantage of the facilities offered by the Laboratory. Assistance was also rendered to cotton breeders in selecting types which would bring higher monetary returns to the cultivator and be more acceptable to the trade and the industry.

Work is in progress on the causes of neppiness in cotton yarns, spinning quality of mixings of Indian cottons with special reference to fibre-properties, influence of different fibre-length groups on yarn-strength, preparation of tyre cords from Indian cottons, etc.

Bulletins on the bleaching of cellulose in linters and the analysis, grading and utilization of Indian linters, were published.

Improved Quality of Moulding Powders

Moulding powders will have better flow, from which articles with improved finish and gloss can be made, if the present method of making them is slightly altered, states the Report of the Indian Lac Research Institute for the year 1944-45. According to the new process the lac-formaldehyde-urea resin solution is first separately made and then mixed in a kneader with fillers, pigments, lubricants, etc., the whole mass being rolled and powdered immediately after mixing. Further by using as filler sawdust which has been defibred by autoclaving or alkali digestion, the shock-resistance of the moulded articles is increased by 30 to 40 per cent. The additional cost of such special treatment of sawdust can be avoided by combining the alkali digestion of sawdust and the recovery of lac from kiri into one single operation.

The effect of incorporating cashew shell oil in the lac-moulding compositions was further studied at the Institute during the year under report. It was found that the oil, partially polymerised by heating at 300° C. for 15—20 minutes and combined in quantities up to 25—30 per cent. of the weight of lac, yielded moulding powders with better flow and augmented the plasticity of the compositions.

It has been found that lac-fatty oil acid varnish suitable for making oil cloth and other flexible waterproof fabrics, has better ageing properties, if made with castor oil fatty acid instead of linseed oil fatty acid. Samples coated with the new varnish have retained their surface gloss and suppleness for well over a year.

Cashew shell oil is not only a useful component of shellac moulding powders but also a valuable ingredient of several varnishes. With the admixture of this oil the varnishes are rendered suitable for waterproofing paper and cloth and for giving acid and alkali resistant coatings on metals. They also possess good insulating and other properties and may be used for making insulating cloth, tape, etc.

A simple method of dewaxing seedlac has been worked out by using kerosene which selectively dissolves out the wax in part, leaving out the seedlac grains intact. The method does not require complicated or costly equipment and removes the wax to the extent of 1.6—2 per cent. The lac wax can be used as a substitute for Carnauba wax.

"Micmark" for Mica

Legislation for grading and standardizing Indian mica for export is under consideration by the Government of India. The Director, Geological Survey of India, it is learnt, is consulting the trade on Government's proposals.

As new sources of mica have been considerably developed during the war in countries like Brazil, Canada and East Africa, and a few substitutes for mica have come into the field competing with the natural mineral, there is an urgent need for providing better marketing facilities abroad for Indian mica by ensuring that the quality of Indian exports is maintained. During the war all the available supplies of mica in this country were bought by the *Joint Mica Mission* who set up their own standards and specifications for grading the article. Since the *Joint Mica Mission* is expected to be wound up

shortly, Indian mica will, hereafter, be thrown on its own resources for finding a stable and regular market overseas.

The contemplated "Micmark" legislation is expected to be on lines similar to the *Agricultural Marketing Act* and for the time being voluntary in its operation. Exporters will have to apply for a Micmark to the Director, *Geological Survey of India*, whose inspecting staff will inspect the mica, grade it and affix the Micmark. It is believed that the standards set up by the *Joint Mica Mission* will be followed initially for grading mica. There will also be a committee composed of mica miners and dealers to advise Government on standard samples and types. The abuse of Micmark will be penalised.

It is also understood that following the proposed legislation, Government have in contemplation the establishment of selling agencies in the U.K. under the High Commissioner, and in the U.S.A. under the Agent-General to the Government of India, for putting exporters of Micmark mica in touch with prospective buyers.

Multi-purpose Development of Orissa Rivers

The possibility of developing the rivers of Orissa for multi-purposes of flood control, navigation, irrigation and drainage, soil conservation and power development was examined at a conference convened by the Central Government at Cuttack on 8th November 1945. The Hon'ble Dr. B. R. Ambedkar, Labour Member to the Government of India, presided.

The conference considered the desirability of undertaking surveys and investigations of the Orissa rivers for preparing schemes of unified and multi-purpose development.

The conference was attended by representatives of the Central Government and the Governments of Orissa, Central Provinces and the Eastern States.

Sheep and Goat Breeding and Marketing

India has the largest goat population in the world and ranks fourth in respect of sheep but her exports are small. The few animals exported are taken only by neighbouring countries like Ceylon and Nepal.

"This is in sharp contrast with the export trade built up by countries like Australia and the Argentine which have specialized in rearing quality stock and exporting the same in carcass form in cold storage," says a Report on the Marketing of Sheep and Goats in India, issued by the Central Agricultural Marketing Department.

The Indian shepherd or goatherd, says the report, still works according to old conservative ideas. Animals sold for slaughter are poor in flesh and yield lean and comparatively non-tasty meat, "partly because they have not received special fattening feeds and partly because their owners do not know at what age they should be castrated and sold in the most economic and profitable way."

An inquiry on these lines is suggested as also further investigation in respect of the approximate number of animals of different breeds, habitat, live-weight, carcass weight and the quality of meat, skins, wool and hair obtained from animals of a particular breed.

A salient point brought out in this report is the possibility of obtaining milk from sheep and goats. There are some very good milch-breeds of sheep and goats in some parts of the country. The Damani sheep is said to give about 3 lbs. of milk a day under

village conditions. All adult she-goats yield milk and in some parts, goats yielding large quantity of milk are also available. Some of these breeds (e.g., Beetal, Dera Deen Panan, Jamnapare) are known to yield as much as 9 to 10 lbs. of milk under proper farm conditions. If these milch animals could be improved upon and acclimatized in different parts of the country, multiplied and distributed at a reasonable price to the poorer people, especially to those who cannot afford to buy milk or keep cows or buffaloes, then it is hoped that in course of time, the health and vitality of the nation would improve.

Sheep and goat markets are usually held in the open, despite inclement weather and extremes of heat and cold. It is recommended that municipalities (which levy fees and taxes on the slaughter of animals) should enclose the market by *pucca* walls, erect sheds for shelter from sun and rain and make adequate arrangements for feeding and watering animals. Brokers in all important markets should be licensed and their number and rate of remuneration fixed according to local conditions.

Tariff Board

The *Gazette of India Extraordinary*, dated 3rd November 1945, states:—"In the statement on industrial policy issued by the Government of India on 23rd April 1945, it was announced that, pending the formulation of a tariff policy appropriate to the post-war needs and conditions of the country, and the establishment of permanent machinery for the purpose, Government would set up machinery for investigating claims from industries, which have been started or developed in war-time and which are established on sound lines, to assistance or protection during the transition period." A Press *communiqué* issued on the same date invited industries to address their claims to the Secretary to the Government of India in the Department of Commerce.

Several industries have accordingly applied for assistance or protection, and on a preliminary examination of their claims, the Government of India have come to the conclusion that applications submitted by the following industries call for a detailed examination:—

(i) non-ferrous metals, including antimony; (ii) grinding wheels; (iii) caustic soda and bleaching powder; (iv) sodium thiosulphate, sodium sulphite (anhydrous), sodium bisulphite; (v) phosphates and phosphoric acid; (vi) butter colour, aerated water powder colour; (vii) rubber manufactures; (viii) fire hose; (ix) wood screws; and (x) steel hoops for baling.

Other applications are under the consideration of Government, and further action in their case will be taken in due course.

In addition to the industries which have applied for assistance or protection, there are certain industries the starting of which was considered essential by the Government of India under conditions created by the war. Early in 1940, Government announced that specified industries promoted with their direct encouragement during war-time might feel assured that, if they were conducted on sound business lines, they would, by such measures as Government might devise, be protected against unfair competition from outside India. In accordance with this decision, the following industries have been given an assurance of protection against unfair competition after the war:—

(i) bichromates; (ii) steel pipes and tubes up to a nominal bore of 4 inches; (iii) aluminium; (iv)

calcium chloride; (v) calcium carbide; and (vi) starch.

Of these industries, only those engaged in the manufacture of bichromates, calcium chloride and starch have so far applied for assistance or protection during the transition period. The Government of India consider that the applications submitted by these three industries also call for immediate investigation.

For the purpose of these and any subsequent investigations, the Government of India have decided to set up a Tariff Board for a period not exceeding two years, in the first instance. The Board will consist of:—

President:—Sir R. K. Shanmukham Chetty, K.C.I.E.

Members:—Mr. C. C. Desai, C.I.E., I.C.S., Prof. H. L. Dey, D.Sc. (London), and Dr. Nazir Ahmad, Ph. D. Mr. Desai will act as Secretary to the Board in addition to his duties as member.

The Tariff Board is requested to undertake, in such order as it thinks fit, the investigation of claims put forward by the industries specified in paragraphs 2 and 3 above. In the case of each industry the Board will, after such examination as it considers necessary, report whether the industry satisfies the following conditions:

(1) that it is established and conducted on sound business lines; and (2) (a) that, having regard to the natural or economic advantages enjoyed by the industry and its actual or probable costs, it is likely within a reasonable time to develop sufficiently to be able to carry on successfully without protection or State assistance; or (b) that it is an industry to which it is desirable in the national interest to grant protection or assistance and that the probable cost of such protection or assistance to the community is not excessive. Where a claim to protection or assistance is found to be established, i.e., if condition (1) and condition (2) (a) or (b) are satisfied, the Board will recommend:—

(i) whether, at what rate and in respect of what articles, or class or description of articles, a protective duty should be imposed; (ii) what additional or alternative measures should be taken to protect or assist the industry; and (iii) for what period, not exceeding three years, the tariff or other measures recommended should remain in force.

In making its recommendations the Board will give due weight to the interests of the consumer in the light of the prevailing conditions and also consider how the recommendations affect industries using the articles in respect of which protection is to be granted. Since relief, to be effective, should be afforded without delay, the Board is requested to complete its inquiries with all possible expedition and to submit a report as soon as the investigation of the claim of each industry is concluded.

Index Number of Industrial Raw Materials

A new series of index numbers of industrial raw material prices has been issued by the Economic Adviser to the Government of India. The base period is the year ended August 1939. It is weighted and consists of 19 items under the groups textile fibres, oilseeds, minerals and other materials. The combined index number was 232.5 in May, 238.1 in June, 244.5 in July, 242.4 in August and 238.1 in the first four weeks of September, 1945.

As in the case of the All-India Index of Wholesale Prices of Food Articles, this All-India Index of Wholesale Prices relating to industrial raw materials will hereafter be regularly issued every week by the Office of the Economic Adviser.

Industrial raw materials constitute an extensive field; but the selection of items from this field for inclusion in a wholesale price index is somewhat limited by lack of price information, particularly in the case of mineral products. However, none of the items which had to be omitted on account of this consideration from this price index has a claim to any appreciable weightage from the point of view of the relative value of output.

The number of commodities included in the compilation of the index is 19. Under "textile fibres," raw cotton, raw jute, raw silk and raw wool have been included. Groundnuts, linseed, castor, rapeseed, cotton seed and copra come under "oilseeds." Under "minerals," coal, manganese ore, mica and iron ore have been included. "Other materials" comprise raw hides, raw skins, lac and rubber. For the purposes of calculation, important and representative varieties of these commodities and their wholesale prices in their main markets have been taken into account.

The weights assigned to the various items in the index are proportionate to the values of the commodities as determined from the estimated quantities marketed and the prices prevailing during the year 1938-39. Thus, in the case of coal the quantity consumed by the miners has not been taken into account. In regard to cotton and jute, as well as oilseeds and hides and skins, a rough allowance has been made for the amount retained by the producers. The estimates of the proportion of the output retained by producers as arrived at in the marketing reports and in the Handbook of Commercial Information and similar sources have been utilized in this connection.

In the absence of evidence to the contrary, it has been assumed that the whole of the remaining output has been put in the market. In the case of commodities like raw cotton, silk, wool and copra, the value of retained imports has also been taken into consideration before distributing the weights.

In the result, the weights assigned to the various items are as follows:—

Cotton, raw	28	Coal	6
Jute, raw	22	Manganese ore ..	2
Silk, raw	1	Mica	1
Wool, raw	2	Iron ore	1
Groundnut	12	Hides, raw	3
Linseed	3	Skins, raw	2
Castor	1	Lac	1
Gingelly	3	Rubber	1
Rapeseed	5		—
Cottonseed	4		100
Copra	2		—

The following procedure has been adopted in introducing weights in the compilation:

The price relatives for the individual varieties of each commodity are averaged geometrically into a single price relative for that commodity. The geometric average of the nineteen price relatives, thus obtained, the proper weights being assigned to each as specified above, is the final index for each week. A separate average is also worked out for each of the four sub-groups, viz., textile fibres, oilseeds, minerals, and other materials.

The Economic Adviser's All-India Index Numbers of wholesale Prices of Industrial Raw Materials (base: year ended August 1939=100) worked out to 239.0 for the week ended 17th November 1945 as compared with 237.0 for the previous week.

Export Control Liberalized

With a view to stimulating export trade, the Government of India in the Commerce Department, by a notification published in a *Gazette of India Extraordinary* dated 3rd November 1945, have revised the schedule annexed to their Export Control notification dated 29th January 1944, entirely decontrolling a large number of commodities and liberalizing control over a wide range of others.

More than one hundred commodities have been removed from the list of controlled items. They include natural indigo, a number of chemicals and chemical preparations, scientific instruments of indigenous origin, certain classes of containers, pyridine, cashew-nuts, certain gums and resins, kapok, lac, cigarette and jewel cases made of wood, articles mainly or wholly made of mica, animal oils, many essential oils, perfumed spirits, soapnut and bhilawan nuts, talc, cigars, cigarettes of indigenous manufacture and unmanufactured tobacco including flue-cured tobacco, toys and requisites for games and sports if not wholly and mainly of rubber, fibres for brushes and brooms, hairs of all kinds, animal bladders, guts and casings, furs and skins, a number of metals and ores (aluminium ore, antimony ore, chrome ore and metal, iron ore, magnesite, manganese ore and manganese, zinc ore, etc.), raw cotton, turkey red oil, essential oil seeds, spices of all sorts excluding pepper and cinnamon and pickles, chutneys, condiments and curry powder.

More than 20 commodities, the export of which was hitherto totally prohibited, have now been transferred to control by the Chief Controller of Exports who will allow small quantities to be exported. This category includes agar-agar, bee's-wax, certain classes of buttons, candles, cinematograph films, cutlery, glue and raw materials for the manufacture of glue, some gums and resins, leather manufactures including footwear and suitcases, stationery, polishes, printers' and lithographers' ink, spectacle frames, vitamin A preparations, Pashmina shawls, carpets, and floor rugs.

Advantage has also been taken of this opportunity to transfer some commodities controlled by other Departments to the Commerce Department. These items include many kinds of drugs, hops and hop products, abrasives, bitumen, carbon black, some chemicals, many instruments, apparatus and appliances, lamps, paints and varnishes, rubber shoes and liquors.

In respect of these and other items a more liberal export policy has been formulated and will now be applied.

Steel, Timber and Cement for Civilian Use

A Press *communiqué*, dated 3rd November 1945, from the Supply Department states:—"In the spring of 1945 the Hydari Mission successfully negotiated with His Majesty's Government for the allocation of 300,000 tons of steel, an additional 600,000 tons of cement and 500,000 tons of timber for civil purposes in 1946, to relieve the strain of the war on India's economy. With the advent of V-J Day, the situation has much improved, so far as the remainder of 1945 is concerned, and allocations for purely civil (non-Government) require-

ments for the last quarter of 1945 are estimated at 68,000 tons of steel, 300,000 tons of cement and 9,000 tons of timber, compared with 47,000 tons of steel, 150,000 tons of cement and 8,000 tons of timber in the last quarter of 1944. The timber figure relates to issues from Government stocks, and is in addition to supplies of timber of types or sizes unsuitable for military and Government purposes; such timber has always been left to civil users.

"For 1946 the prospects are good. Excluding the quantities required for the heavy rehabilitation programmes of the Railways and other Central Departments, and of the Provincial and State Governments, it is estimated that 585,000 tons of steel will be available for civil purposes in 1946. The allocations of steel against actual civil demands for the first half of 1946 total 271,000 tons, representing 92 per cent. of the immediate pre-war consumption over a corresponding period.

"Allocations of cement for similar civil purposes depend to some extent on the take-off for military and Government purposes, but a broad figure of 125,000 to 130,000 tons a month is in view. Improvements in the coal deliveries could increase production from existing cement factories to the extent of 20,000 to 30,000 tons a month which would go on to the quota available for civil purposes; while new production projects if they came into operation would add further to the civil supply.

"The chief point of the timber supply will be the diversion to civil uses of the 540,000 to 600,000 tons of timber of types hitherto utilized for Defence and Government purposes. This will be in addition to other types of timber unsuitable for military and Government purposes which, as already observed, the civil consumer has enjoyed throughout.

"Apart from the three commodities, steel, cement and timber, some comment on that fundamental commodity, coal, is appropriate. There have been in recent months welcome indications of a return to normal. Up to the end of September over 1.7 million tons more have been raised and despatched this year than in the first nine months of 1944. Despatches of coal to all classes of consumers in 1945 are estimated to be 25½ million tons or 2.17 million tons more than in 1944. In 1946, despatches will certainly exceed 25½ million tons, and given favourable transport conditions, might do so to the extent of another 4 million tons. Deducting what is required for all Government purposes—principally the railways—the coal available in 1946 for all Provincial, Indian State and industrial purposes should be of the order of 16 million tons as against 11.3 million tons and 13.1 million tons in 1944 and 1945 respectively. Special attention is being given to the question of releasing all possible coal suitable for burning bricks required for private enterprise without infringing on the requirements of essential industry, and in the last quarter of 1945 the despatches of coal specifically allocated for this purpose are expected to be about 125,000 tons against actual deliveries of 25,000 tons in the last quarter of 1944."

Indian Imports into Australia

It is understood that the Australian Government have recently removed or eased import licensing restrictions on a large number of goods.

Among the items exempted from Licensing Control the following are of interest to India: bees-wax, handkerchief cloth in the piece, potassium nitrate, shellac, needlac, cutlery, spoons and forks, precious

stones and semi-precious stones, manufactured tobacco and cigarettes and fine-cut tobacco, tapestries and moquettes.

India Supply Mission, U.K.

Mr. P. C. Chaudhuri, I.C.S., who was deputed to London by the Commerce Department, it is understood, has set up a special organization for sponsoring procurement of capital and other goods to India from the U.K. market, at 45, 46 and 47 Mount Street, London, W.1. The organization will be known as the India Supply Commission, with Mr. Chaudhuri as its Director. It will take over practically the whole of the agency work hitherto undertaken in the Economic and Overseas Department of the India Office in connection with supplies to India.

The work of the new organization will cover registration, co-ordination and processing of all import licences, sponsorship of shipments, programming and progressing of requirements of machinery, plant, equipment and other civil requirements. The main items which the new organization will be required to sponsor are heavy electrical plant scheduled through the Central Technical Power Board, other power plants including boilers, etc., machine tools, textile machinery of all kinds, food machinery including vegetable oil and *ghee* plants, cement machinery, road making machinery, tea machinery, chemical manufacturing plant, refrigeration machinery, agricultural and crawler tractor and coal mining machinery and plant.

Other requirements to which particular attention will be given are mill stores of all kinds, motor vehicles, drugs and medicines and raw materials including steel, dyes, chemicals, and fertilizers.

The new organization will also deal with post-war requirements of capital goods including artificial fertilizer plants and special requirements of projects such as irrigation and hydro-electrical schemes, etc.

In addition, the organization will represent the Government of India at various committees at which India's requirements are planned.

Indian Experts to Visit Germany

At the request of the Planning and Development Department of the Government of India, His Majesty's Government have agreed to include five Indian expert technicians in the appropriate teams of British and American experts going to Germany to investigate specified industrial and technical processes likely to be advantageous to allied industrial production.

Scientific Consultative Committee

The second meeting of the Scientific Consultative Committee met recently in New Delhi. The Hon'ble Sir Ardeshir Dalal presided.

The Committee considered the Report of the *Industrial Research Planning Committee* which was presided over by Sir Shanmukham Chetty, the Hill Report and certain alternative suggestions received from members regarding the organization of scientific research in India, in particular a scheme based on the Australian pattern. A point on which difference of opinion continues to exist is whether a central body should merely co-ordinate research carried out by specialist bodies or direct and control them. In the light of the discussions at the Committee meeting, the Hon'ble Sir Ardeshir Dalal will submit a scheme to the Government of India suitable for present-day conditions in India.

The Committee decided that it would be wiser to wait for some time before starting new research institutions, proposed by the Chetty Committee, as a number of them had recently been started. It was, however, felt that an Institute of Food Technology was essential.

On the question of cess to be levied on industries to finance research, the Committee agreed that the principle of cess on industry was sound, but the method of collection should be by a surcharge on income-tax paid by industrial undertakings. The amount of contribution by industry should be the same as that of Government.

The grants to universities recommended by the Chetty Committee, it was agreed, should not be made conditional on the universities securing similar grants from other sources.

The Committee further considered the status and emoluments of scientists in the country. The emoluments paid to scientists, according to the Committee, were very low and it was recommended that no scientist should be given less than Rs. 200 a month whether in Government service or in universities. It was further recommended that the maximum in the case of academic scientists not doing administrative work should not be less than Rs. 1,500.

In view of the fact that the National Chemical Laboratory and the Institute of Glass and Ceramic Research were both going to have pilot plants, it was agreed that no separate pilot plant institute would be required.

An interim plan for scientific co-ordination, suggested by Dr. Sir S. S. Bhatnagar, was accepted by the Committee, who also agreed with the Chetty Committee's recommendation for a National Trust for Patents and a Board of Standards and Specifications.

Announcements

The **Watumull Foundation, Los Angeles**, propose for the academic year of 1946-47 to award ten Fellowships to young Indian faculty members of Indian universities to carry on advanced studies and research in American Universities for one or two years as individually required. These Fellowships will be awarded with the definite understanding that, after their return to India, they will continue to teach in the same universities where they were employed prior to their departure for the United States, for a period of at least three years. The Fellowships are open to both men and women, regardless of caste, colour or creed.

The authorities of every Indian university will select two to four candidates, who in their judgment, are most able to acquire the knowledge of the specific subjects which they will teach in the universities after their return to India with the definite objective that the standard and efficiency of their universities will be raised. The applications of the candidates selected

by the Indian universities will be sent by the Vice-Chancellors or the Deans of the Faculty, to the Chairman of the **Watumull Foundation Advisory Board** in India who will send them by air mail to the special committee on the selection of scholars in the United States, who will choose ten candidates on the basis of merit only. Further details can be had from Mr. J. Watumull, Fort Road, Hyderabad (Sind).

Sir M. Visvesvaraya has been re-elected President of the **All-India Manufacturers' Organization** for the year 1946.

Dr. Nazir Ahmad has been appointed Member of the recently constituted Tariff Board. He assumed charge of his office on 15th November.

Mr. K. S. Sashachalam Chaudari has been appointed Hon. Professor in Leather Technology, University of Madras. The Institute of Leather Technology was recently established in Madras, and the Governing Body of the **Council of Scientific and Industrial Research**, at its last meeting (21st September 1945) decided to make an annual block grant of Rs. 60,000 to the University of Madras, towards the recurring expenditure of the Institute.

Sir S. Radhakrishnan has been re-elected Vice-Chancellor of the Benares Hindu University.

The **Sir C. R. Reddy National Prize** for 1945 has been awarded to **Prof. S. Chandrasekhar, F.R.S.** The Prize was awarded *in absentia* on 6th November at the Annual Convocation of the Andhra University.

Prof. Chandrasekhar, who holds the chair of Astrophysics at Yerkes Observatory of the Chicago University, has accepted a Professorship in the **Tata Institute of Fundamental Research, Bombay**, and is expected to return to India shortly.

Institution of Engineers (India).—Mr. P. R. Agarwal, B.Sc. (Eng.), M.I.E. (India), Deputy Director, Mechanical Engineering, Railway Board, has been awarded the Railway Board Gold Medal and first prize by the **Institution of Engineers (India)** for his paper on "Diesel Traction in Railways in Post-war."

Mr. Coes of Messrs. Ford, Bacon and Davis, the foremost engineering firm of America, has arrived in India at the invitation of the Government to advise on the expansion of the Indian engineering industry.

Hydrogenation Factory at Calicut.—In a Press Note dated 2nd November, the Government of Madras state that a sum of Rs. 9,18,400 has been sanctioned towards building and machinery, and Rs. 50,64,600 towards the working expenses of the Hydrogenation Factory at Calicut. The plant will have a capacity of 18 tons refined and 10 tons hydrogenated oil per day. Besides being a commercial concern, the factory will provide facilities for training students and technical personnel in oil technology and for conducting research on vegetable oils in regard to improving their nutritive value.

Reports from States and Provinces

Bihar

THE Department of Industries in Bihar has recommended the following schemes for technical training and industrial development for adoption in the post-war five-year plan:—

(i) Expansion of the Bihar College of Engineering. Degree courses in electrical and mechanical engineering will be introduced in the College. Facilities exist as present for training 30 students for the Degree in civil engineering.

(ii) Establishment of an Industrial Research Laboratory at Patna. The Laboratory will undertake investigations on the utilization of raw materials and on *ad hoc* problems referred to it by industries. The Laboratory will be adequately staffed and equipped for carrying out fundamental and applied research in chemistry, biochemistry, mineralogy and electro-technology. It will serve as a clearing house for industrial and scientific information, and it will work in co-operation with the Patna University and with the National Research Laboratories.

(iii) A technical and engineering school at Bhagalpur. Courses of study in several technical subjects including civil engineering will be started.

(iv) Establishment of an industrial and commercial school for women and girls at Patna.

(v) Award of scholarships for technical education abroad.

(vi) Technical education loans fund. Provision has been made for advancing loans without interest, to qualified persons who wish to proceed overseas for training. It is proposed to set apart Rs. 25 lakhs for this purpose in five years.

(vii) Opening of new technical schools at Dhanbad and Bettiah, improvement of the existing technical school at Dehri-on-Sone and opening of a new technical school at Hazaribagh in place of the existing artisan classes.

(viii) Expansion of the technical school at Ranchi.

(ix) Improvement of the Industrial Diploma Section of the Tirhut Technical Institute, Muzaffarpur.

(x) Addition of a new tanning section to the Tirhut Technical Institute, Muzaffarpur, and improvement of the existing Leather Section.

(xi) Grants-in-aid to technical institutions.

(xii) Starting of a College of Science and Technology with the following aims and objects: (a) to provide ordinary Intermediate Science education to those who wish to take up industrial careers, and (b) to train students for a Degree course in industrial subjects.

The total cost of the twelve schemes listed above will be Rs. 188.31 lakhs, spread over a period of five years.

The Department of Industries since its inception has devoted considerable attention to the development of cottage industries. The textile section of the Department started with an annual grant of Rs. 20,000, and during the past 25 years its activities have greatly increased as reflected in the budget grant of Rs. 25 lakhs last year. In the post-war development plan, the handloom weaving industry will receive additional encouragement. It is proposed

to establish demonstration weaving factories at the weaving centres, where improved types of dobies, jacquards, treble shuttle looms and other appliances will be demonstrated under actual working conditions. This scheme will involve an expenditure of Rs. 1,28,000 spread over five years. Vocational "half-time" weaving schools, and textile institutes for advanced training in handloom weaving have been proposed.

Wool spinning and weaving have made spectacular progress during the past few years, mainly as a result of the efforts of the Department. Local spinners have been encouraged, through demonstration and instruction, to use finer Tibet wool and turn out soft rugs and blankets. The Wool Weaving Institute at Gaya has been expanded and it is proposed to start two more institutes for training supervisory and technical staff required for the whole province.

Bihar produces the largest amount of *tasar* silk in India. The pre-war annual production was 2 lakhs lbs. There is ample scope for increasing the production. Provision has been made in the post-war plan for starting two *tasar* silk farms at a cost of Rs. 2,30,000 in five years. These farms will undertake the work of domesticating *tasar* seed worms, cross breeding with wild and other races for increasing vigour, rearing of single layings for pure and improved breeds, etc.

There are several regions in North Bihar which are suitable for the production of mulberry silk. In the past, such silk was actually being produced. The Department has prepared a scheme for reviving the industry and it is proposed to start a mulberry silk farm at a total cost of Rs. 58,000.

Bihar occupies the second place in India in the production of *eri* silk. Castor is grown in abundance all over the Province for castor seeds, and for feeding *eri* silk-worms. In the Ranchi *Eri* Seed Supply Station, disease-free eggs are collected and distributed to *eri* silk producers. The Departmental post-war scheme provides for the establishment of a second farm in North Bihar. Besides rearing of worms, the farm will serve as a demonstration centre for spinning, reeling and weaving of *eri* silk.

It is proposed to establish two silk Technological Institutes at an estimated cost of Rs. 3,74,000, spread over five years, to train the staff required for popularizing silk production in the Province.

The handloom marketing organization will be considerably expanded in the post-war years. Cottage industries have been greatly benefited by the Department's efforts and there is need for greatly expanding the Departmental marketing organization and for encouraging co-operative societies.—(Through the Courtesy of the Department of Industries, Bihar.)

Punjab

The Thal, Bhakra and other projects included in the five-year development plan of the Punjab Government, when completed, will provide additional irrigation to nearly four million acres of land and generate 200,000 kw. of cheap electric power, said Mr. Akhtar Hussain, I.C.S., in a recent talk from

the Delhi station of All-India Radio, describing the Punjab's post-war reconstruction and development plans.

The plan has been formulated on a long-term basis and the first five years are intended to be a period of preparation, training and experiment. The plan contemplates an expenditure of Rs. 100 crores, out of which nearly Rs. 45 crores will be spent on irrigation, hydroelectric and electricity projects. With the construction of the Thal Project, work on which has already been started, the Punjab canals will have fully utilized the entire winter discharge of the rivers of the Province. Investigations have shown that a number of excellent sites are available in the Himalayas for the storage of surplus water during the monsoon period which at present runs waste to the sea.

Afforestation and anti-erosion schemes, estimated to cost Rs. 2 crores, will reclaim about 150,000 acres of waste land and increase the productivity of 350,000 acres of poor and untiered land. To encourage scientific methods of farming, it is proposed to establish a network of experimental, demonstration and seed farms all over the Province.

Cottage industries occupy the first place in the post-war plan for development of industries. Other schemes provide for specialized industrial training, initiating intensive industrial research in the utilization of the resources of the Province, a pilot workshop for designing and manufacturing machines and appliances suited to Indian conditions and for sponsoring new industries like coal-tar distillation, which had not been yet attempted by private enterprise.

Other schemes which have received attention are: A 35-year plan for the development of education, extension of medical facilities in rural areas and expansion of medical education, and a 15-year road development programme.

Bengal

Post-war Plan of Reconstruction

The first instalment of a twenty-year post-war plan for Bengal, dealing with those schemes which are considered most urgent and which can be executed within the first five years, has been published.

The plan which concentrates primarily on agriculture, envisages liquidation of the Permanent Settlement, first in the districts of Bakarganj, Faridpur, Burdwan, Hooghly and Sunderbans. The entire Province will be covered in 23 years. The cost is estimated to be Rs. 12 crores in the first quinquennium.

Two major irrigation projects are considered: the Damodar Valley Project which the Government of India have since undertaken to execute, and the More Reservoir Project involving the construction of a weir at Khatanga and a dam for the generation of electric power. In other areas in Western and Central Bengal, 47 smaller irrigation and drainage projects are to be executed, designed not only to benefit agriculture but to improve rural sanitation by removing waterlogging.

The largest of the land development schemes is connected with reclamation of waste lands in Western Bengal where, it is estimated, some 1,000 square miles of land have been lost to cultivation through erosion. The land is to be farmed collectively to facilitate mechanical operations.

Ceylon

COLOMBO,
30th October 1945.

The Government have prohibited the importation into Ceylon of rubber soles and heels in view of the fact that the premier rubber manufacturing concern in the island, viz., *Richard Pieris & Co., Ltd.*, has started producing them on a sufficiently large scale. The same firm has applied to the Government for protection to manufacture for home consumption cycle tyres, tubes and moulded rubber goods. One of the forms of assistance asked for is the importation of the required machinery, free-of-duty or at a low rate of duty. In the meanwhile, the Government itself has a plan for starting a cycle tyre and tube factory, and it is understood that a research scholar is now in the United Kingdom specialising in rubber technology.

The purchase of Ceylon mica by the *Anglo-American Mica Mission* ceases by the end of November. The immediate future of the mica industry is reported to be not very promising, as no steps have been taken to find new markets in view of the prohibition by the Ceylon Government of the export of mica. The Island's mica industry was resuscitated in 1942 under the stress of war, and about 25 mica mines are now being worked.

Mr. K. T. Achaya, Government Silk Expert, has presented his "Report on the Possibilities of Establishing and Developing the Silk Industry in Ceylon" (*Sessional Paper VII, 1945*). According to the report, ideal conditions prevail in Ceylon for developing sericulture. Mulberry will grow in all parts of the island. The uniformly warm climate of Ceylon is favourable to the rearing of the worms. Without State aid and encouragement, however, the industry cannot be developed. The State alone can maintain the expert staff required for the development of the industry. Mr. Achaya is awaiting sanction of the Government to start a few farms in the island.

That the future control of malaria in Ceylon must be planned on a large scale and executed boldly is the verdict of the Departmental Committee on malaria in its report issued as a sessional paper. In view of the increasing importance which colonization schemes will assume in the post-war period, and since all the major schemes will be located, as at present, in the dry zone, the extermination of malaria is the prime public health problem. A number of proposals for the future organization of malaria control have been made, including the creation of a separate malaria training institute with a laboratory, library, museum, stores and workshop.

The Minister for Agriculture has announced that rice import will continue to be State-controlled. This has been followed by the publication of the recommendations of the Paddy Advisory Board. The creation of a Sub-department solely devoted to paddy is contemplated. It is stated that paddy will always be grown in the island because of the traditional dignity attached to that occupation. But as the cost of production is higher than the price at which imported rice is available, paddy growers produce just enough to meet their own needs. In order to encourage cultivation, the continuance of a guaranteed price for paddy as a subsidy for a period of five years, with the added promise to review the position at the end of that period, is recommended.

S. R. K. M.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for September-October, 1945.]

32231. AN IMPROVED SURFACE OR SHEET FORMED FROM STRIPS OF PLYWOOD OR REINFORCED PLYWOOD AND PANELS MADE THEREWITH FOR USE IN FURNITURE AND OTHER PURPOSES: *Sheets woven from plywood veneers.*—Ply Wood Products.
32283. SYNTHETIC RUBBER: *Mixing soluble aluminium salt with aqueous dispersion of a polymerised butadiene hydrocarbon or a mixture of butadiene hydrocarbon and vinyl compound, containing a soap.*—Firestone Tire & Rubber Co.
32313. HINGE OR OTHER SHAPED ARTICLE FROM PLYWOOD AND APPARATUS THEREFOR: *Veneers bent round a pin, glued and pressed to form loops, when the pin is withdrawn.*—Plywood Products.
32368. THERMIONIC VALVE AMPLIFIER CIRCUITS: *Amplifying stages are in cascade, each stage using a filter for feeding back its output to the input side, the output anodes being connected directly to the respective succeeding stages.*—The Mullard Radio Valve Co., Ltd.
32448. SURFACE CLEANING OF METAL ARTICLES: *Surfaces of metal articles are cleaned by first subjecting them to the action of strong oxidising acid and then by placing them as an anode in an electrolytic system.*—Rylands Bros. Ltd.
32489. STAINLESS STEELS AND LOW CARBON FERRO-ALLOYS: *Preheated ore, reducing agent and slag making agents devoid of all moisture, are introduced into a furnace containing molten low carbon steel and the thick viscous basic slag formed is superheated to obtain a more fluid slag whereby the oxides are reduced to the alloying metal.*—African Metals Corp. Ltd.
32506. BARKING MACHINE: *Forward feeding of the logs in contact with bark removing chains fixed to rotatable supports.*—Svenska Cellulosa Aktiebolaget.
32573. LAMINATED CORES FOR TRANSFORMERS AND OTHER ELECTRICAL APPARATUS: *Laminations provided with slots, forcing a wire or strip of softer materials after stacking.*—Standard Telephones and Cables Ltd.
32610. COMPOSITE OR CLAD METALS: *Two different metals heated in an induction furnace in non-oxidising atmosphere and pressed at welding temperature.*—Robiette.
32619. SPONGE RUBBER: *Incorporation of partly saponified fatty acid in latex compounded and foamed so as to be coagulated and vulcanised by subjection to heat above 100° C.*—Bintex Ltd. and Binns.
32623. POWDERED SILK OR SILK-LIKE FIBRE DUST FOR USE IN THE PREPARATION OF COSMETICS AND/OR PHARMACEUTICAL PRODUCTS: *Acid treatment of silk fibres in one bath, followed by removal of excess acid and addition of preservatives like borax in another bath.*—Laird.
32634. SAFES AND THE LIKE: *Hollow jamb closed by a reinforcing member which projects into a groove in the inner casing of the safe.*—Godrej & Boyce Mfg. Co., Ltd.
29993. INSECTICIDAL COMPOSITIONS: *Comprising one or more of benzene hexachloride in intimate association with carrier material.*—I.C.I. Ltd.
30732. HEAT EXCHANGE DEVICES: *Heat exchange device made by forming the elements of the matrix from a metal or alloy which is amenable to a brazing operation.*—I.C.I. Ltd.
31441. PEST CONTROL AGENTS: *Comprising a fertiliser and at least one isomeric form of benzene hexachloride.*—I.C.I. Ltd.
31616. SULPHANILAMIDE DERIVATIVES: *Heating a 2-(p-acylaminobenzene-sulphonamide)-4-methylpyrimidine-6-carboxylic acid.*—I.C.I. Ltd.
31816. IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF PEST CONTROL AGENTS: *Pest control composition comprising chlorinated cyclohexane with a diluent by chlorination of cyclohexane or monochloro cyclohexane under radiation.*—I.C.I. Ltd.
31917. DEHYDRATION OF FLUID MATERIALS CONTAINING BIOLOGICAL SECRETIONS BY SUBJECTING THE MATERIAL TO A HIGH FREQUENCY ELECTRIC FIELD: *Agitating the fluid and subjecting it to radio frequency field.*—Radio Corp. of America.
31919. AIR OR GAS COMPRESSORS AND VACUUM PUMPS: *Double compression achieved by using both sides of piston in single cylinder.*—David.
32013. WOODEN FRAMED BUILDINGS AND OTHER STRUCTURES: *Frame poles are joined by rods passing through pole holes.*—Opperman.
32104. REFINING HYDROCARBON OILS: *Efficient conversions of crude stock into products of distillation under heat and pressure in a specially designed apparatus.*—Records.
32360. PROCESS RELATING TO THE TREATMENT OF LEAFY MATERIALS AND THE PRODUCTION THEREFROM OF CAROTENE CONCENTRATES SUITABLE FOR FORTIFICATION OF EDIBLE OILS AND FATS: *Process for obtaining carotene concentrates suitable for enriching edible fats, oils by subjecting leafy materials to alkaline hydrolysis followed by extraction with fat or solvent.*—Sreenivasan and Vaidya.
32648. FRACTIONAL DISTILLATION AND LIKE OPERATIONS: *Condensate flung back to evaporator under centrifugal force from truncated cone surface of internal centrally rotating condenser.*—Anglo-Iranian Oil Co., Ltd.
32706. WEAVING LOOMS: *Scrapers moving transversely relatively to warp and scraping them to vibrate to ensure the return of the warp in correct positions.*—Saint Freres Societe Anonyme.
32751. IMPROVEMENTS IN OR RELATING TO ELECTROLYTIC CONDENSERS: *The leading-out wires of an electrolytic condenser are employed as the mandrel over which the sheets of metal foil are rolled so that the central cavity in the rolled sheet is avoided.*—Telegraph Condenser Co., Ltd.
32734. PENICILLIN: *Cultivation of penicillinous notatum in an aqueous nutrient medium containing a proteinaceous material.*—Moyer.

32752. ELECTRICAL CONDENSERS: *Alternate metal plates of a stacked type of condenser are supported on a conductive stem to form one pole while the remaining are connected to a metal casing forming the second pole.*—The Telegraph Condenser Co., Ltd.
32369. APPARATUS FOR GENERATING MECHANICAL VIBRATIONS: *Compressed air passed in channel having weight to get mechanical vibrations.*—The Mullard Radio Valve Co., Ltd.
32413. SWITCH RAILS FOR RAILWAY AND LIKE PERMANENT-WAY: *A switch having swell in heel and projecting from switch rail web.*—Esteves.
32431. HEAT EXCHANGERS FOR CONTINUOUS TREATMENT OF FLUENT MATERIAL: *Material passing successively in axially spaced series of compartments forming scoops at railing ends.*—Lashchinger.
32511. SHUTTLES FOR LOOMS: *With an open top and a cop-holding device comprising spring blades or loops to be pressed back by the cop when inserted.*—James Mackie and Sons Ltd.
32533. LIQUID FUEL BURNERS OF THE PRESSURE TYPE: *Cleaning needle held within vaporiser tube capable of entering the orifice by depression.*—Imber Research Limited.
32548. SEPARATION OF HORMONES OF PROTEIN NATURE: *Subjecting the extract or the suspension containing hormones to electrophoresis.*—Organon Laboratories Ltd.
32674. ELECTRIC SWITCHES: *Magnet for retaining moving contact in one position and a spring push-button effects rapid movement of the moving contact relative to fixed contact dash hot for delaying return of moving contact.*—The Electrical Apparatus Co., Ltd.
27219. DEHYDRATION OF ACETIC ACID: *Distilling with an ester as the principal entrainer and a supplementary entrainer which is insoluble in water and capable of forming an azeotropic mixture boiling at a lower temperature than the azeotropic mixture of the ester and water.*—Les Usines De Melle.
31110. SPRAY OF ATOMISED LIQUID: *Vessel having a closure member, a fluid delivery tube, and a sparkable projection to said closure member.*—Sparklets Ltd.
31298. SPACE FILLING MATERIAL, SUCH AS FOR USE IN UPHOLSTERY AND LIKE PURPOSES: *A net work of mutually entangled fibres entangled with fibrils in co-operative relation is bounded at spaced points.*—The Sponge Rubber Products Co.
31405. DIRECTIONAL AERIAL SYSTEMS: *System of central aerial surrounded by symmetrically situated side aeriels on a line.*—Marconi's Wireless Telegraph Co., Ltd.
31569. INTERNAL COMBUSTION ENGINES AND CYLINDER CONSTRUCTIONS THEREFOR: *Having a cylinder block and a head secured thereto, and gasket means interposed between the block and the head.*—Ford Motor Co. of Canada, Ltd.
31811. A LABORATORY SANDBLASTING EQUIPMENT: *Air is forced through a jet to drive sand.*—Rao.
31858. PANEL UNITS FOR WALL BUILDING: *Vertical posts and panel units having shoulders and interengaging parts.*—Madger.
31925. AUTOMATIC SPEED LIMITING DEVICE FOR HYDRAULIC TURBINE ROTORS: *Ring of speed limiting vanes and an enveloping belt.*—The English Electric Co., Ltd.
31977. MATERIAL AND TOOLS FOR GRINDING AND LIKE PROCESSES: *Abrasive wire is made by dispensing abrasive powder in matrix contained in a sheath reducing the assembly and removing the sheath.*—Everett.
31995. ELECTRIC RESISTANCE FURNACES: *With edge-winding of a resistance strip and disposing more turns at the ends than at centre.*—The Mullard Radio Valve Co., Ltd.
32005. POLYMERIC MATERIALS: *Polymerisation of vinyl fluoride under pressure and temperature and in presence of an organic peroxy compound.*—E. I. Du Pont de Nemours & Co.
32145. METHOD OF MAKING WALLS AND OTHER BUILDING STRUCTURES: *Bricks having vertical cavities on all the four sides are arranged in layers and the cavities are filled up.*—Mukerjee.
32159. A MACHINE FOR FITTING THE GLASS INTO THE RIM OF A WATCH: *Comprising a U-shaped body, with a plunger, at the end of one member, the plunger travelling transversally between the ends of the body and carrying one part of the die at its lower end, the other member carrying the other part of the die.*—The Pioneer Watch Co.
32206. ELECTRIC FUSE BOXES: *For replaceable cartridge fuse comprising a moulded insulating block formed with compartments for receiving U-shaped fuse clips and connector sockets.*—J. A. Crabtree & Co., Ltd.
32216. CHRONOMETERS: *Indicating time, date, days and time at any part of the globe.*—Hall.
32362. NINEPINS: *Runway is in two or more sections.*—Rieger, Marer and Pollak.
32929. FOAM-PRODUCING APPARATUS: *An apparatus of the type in which foam-forming liquid is led to the mixing body at the bottom of a closed tank into which air is introduced above the point at which the liquid and gas meet.*—The Pyrene Co., Ltd.
30992. MULTISTOREY BUILDING CONSTRUCTION: *Steel frame in which stanchions and beams are not continued through pre-fabricated units at the joint.*—Head, Wrightson & Co., Ltd.
31453. WATER LIFTING BY CENTRIFUGAL PUMP WITH HUMAN OR ANIMAL POWER: *A line of sprocket wheels connected to the pump shaft at one end and the main driving shaft at the other.*—Ambike.
31945. ROTARY PUMP: *Cylinder held in a frame, helical impeller in the cylinder and V-pulley, the impeller shaft being enclosed by connecting the cylinder ends to suction and delivery.*—Chadray.
32155. MACHINE FOR CUTTING "SHAPES" FROM SHEET MATERIAL: *Cutting knives arranged in multiple pattern of shapes in the machine.*—Collinson.
32320. FISHING ROD: *Fishing tackle made of triangular bamboo pieces glued and pressed together.*—Geoffrey.
32411. TELEPHONE SYSTEMS: *Employs voice frequency signals for supervision at the operator's position by indicating signals repeated at predetermined intervals.*—Automatic Telephone & Electric Co., Ltd.
32488. AN IMPROVED SELF-LOADING PISTOL: *Explosion gases actuate a mechanism to re-cock trigger mechanism and feed a fresh bullet in the breach.*—Zygmunt De Lubicz-Bakanowski and T. Tarnowski.
32587. ICE BOX: *An ice box having two compartments, an upper one containing a block of ice and a lower one containing foodstuffs on shelves cooled by melting water not actually contacting the foodstuffs.*—Whyte.

Journal of Scientific and Industrial Research

CONVERSION OF *ORTHO*- AND *PARA*-NITRO CHLORO-BENZENES TO THE CORRESPONDING ANISOLES AND PHENETOLES

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O*RTHO*- and *para*-nitroanisoles and nitrophenetoles are valuable dyestuff intermediates. *Ortho*-nitroanisole is an intermediate for the production of direct cotton colours like *Benzo Purpurine 10B*, and *Dianisidine Sky Blue*. *Para*-nitrophenetole, besides being a dyestuff intermediate, is also necessary for the production of the drugs phenacetin, methacetin, lactophenin, phenokoll, etc.

Originally, these compounds were produced solely by the methylation or ethylation of the corresponding nitro phenols, by heating under pressure with alkyl chlorides. The method has now become obsolete after the finding that *ortho* and *para*-nitrochlorobenzenes could be converted to the anisoles and phenetoles by replacement of the halogen atom.

Heumann¹ obtained only pp' dichloroazoxybenzene by boiling *para*-nitrochlorobenzene with alcoholic potash. Willgerodt² showed later that *para*-nitrophenol and *para*-nitrophenetole were also products of the reaction and that by dilution of the alcohol, the formation of dichloroazoxybenzene could be diminished. Blom³ studied the kinetics of the reaction and found that by using aqueous alcohol at 70° no dichloroazoxybenzene was formed.

From a technical point of view, the most significant work on the conversion of nitrochlorobenzenes to the alkoxy derivatives particularly of *para*-nitrochlorobenzene to *para*-nitrophenetole was first carried out by Richardson⁴ who conducted an elaborate

study of the influence of temperature, alcohol and alkali concentration on the conversion. According to this author, the best yields are obtained by heating the nitrochlorobenzene with 0.5 N solution of caustic potash in 95 per cent. alcohol, pre-treated to remove aldehyde at 60° for 140 hours. By this procedure, *para*-nitrophenetole was obtained in 92 per cent., *para*-nitroanisole in 96 per cent. and *ortho*-nitrophenetole in 90 per cent. yields. *Para*-nitrophenol was the only by-product.

Later work on the conversion of nitrochlorobenzene falls into two classes. In the first class, the rate of addition of alkali is regulated. According to the patent taken by the *National Aniline Chemical Company*⁵, the nitrochlorobenzene is boiled with alcohol and the reflux alcohol is allowed to flow through finely powdered sodium hydroxide before re-entering the reaction chamber, thus ensuring the gradual introduction of sodium hydroxide into the system. The operation is stated to take 40 hours and is conducted in a specially designed vessel. McCormack and Stockmann,⁶ achieve the same purpose by heating the nitrochlorobenzene with alcohol and sodium silicate in an autoclave at 150° C. By this procedure a moderate OH concentration is maintained by the hydrolysis of the silicate. Riklis⁷ describes a procedure in which *O*-nitrochlorobenzene is heated in an autoclave at 90° C. for 60 hours and the alcoholic sodium hydroxide added at intervals. The patent granted to Clemmensen⁸ seeks

to convert the nitrochlorobenzene by heating with a metal alcoholate such as sodium methoxide.

In the second class, the formation of by-products like dichloroazoxybenzene is sought to be prevented by the aid of suitable catalysts. The use of cuprous chloride and glycerol as a catalyst for the purpose is mentioned in a German patent⁹. Groggins¹⁰ describes a procedure, probably abstracted from a patent specification, in which the nitrochlorobenzene is heated with alcoholic potash from 50° to 80° C., increasing the temperature by 5° during every 5 hours, the whole operation taking 56 hours. The formation of by-products is stated to be completely suppressed by the addition of potassium sulphite at regulated intervals, and the yield of the desired product is stated to be quantitative. Aoyama and Kizonanai¹¹ have made a valuable contribution by conducting a study of the influence of several catalysts in suppressing by-product formation. According to these authors, a mixture of manganese dioxide and cobaltic oxide is the best catalyst for the purpose and the use of this catalyst under certain specified conditions yielded *para*-nitrophenetole in 92.2 per cent. and *ortho*-nitroanisole in 90.3 per cent. yields.

The procedures described by Richardson. Groggins and Aoyama seemed to be the simplest and most suitable for adoption on a technical scale. However, the method of Richardson requires the use of alcohol specially pre-treated to remove aldehyde and is extremely slow, taking nearly 140 hours for completion. The procedure described by Groggins is also slow and involves the use of potassium hydroxide and potassium sulphite which are not recoverable. The work described in this paper was undertaken with the object of ascertaining how far the results claimed by previous authors were reproducible and evolving, if possible, procedures which would be quicker and lead to products of high purity in better yields.

The Method of Groggins.—The experimental procedure described by Groggins (*loc. cit.*) was repeated carefully, using potassium hydroxide of C.P. quality and freshly prepared potassium sulphite. In the first experiment, ordinary alcohol of 94 per cent. strength was used. The yield of *para*-nitrophenetole was 46 per cent. of theoretical and the quality of the product

was poor, the m.p. being 48° C. In the second experiment, 1,570 gms. of *para*-nitrochlorobenzene with 10 litres of aldehyde-free 95 per cent. alcohol and the specified amounts of potassium hydroxide and potassium sulphite, by operating according to the procedure of Groggins, yielded 880 gms. of *para*-nitrophenetole in 51.4 per cent. yield, the m.p. being 58° C. 465 gms. of *pp'* dichloroazoxybenzene were formed as by-product besides some chloraniline and *para*-nitrophenol.

In the light of the results obtained, it must be definitely stated that the procedure of Groggins is unsuitable even as a preparative method.

The Method of Richardson.—The following results were obtained on repeating Richardson's procedure.

TABLE I.

6 gms. of nitrochlorobenzene in 200 c.c. of 0.5 N. sodium hydroxide solution (Richardson used potassium hydroxide) in 95 per cent. aldehyde-free alcohol at 60° C. for 140 hours.		
Product	Yield in grams	Percentage yield
<i>Para</i> -nitrophenetole	5.4	85.4
<i>Para</i> -nitroanisole	5.2	89.2
<i>Ortho</i> -nitrophenetole	5.5	87.0
<i>Ortho</i> -nitroanisole	5.1	87.5

On a slightly larger scale, 72 gms. of *para*-nitrochlorobenzene in 4.5 litres of 95 per cent. aldehyde-free alcohol and 90 gms. of potassium hydroxide at 60° C. for 140 hours yielded 70 gms. of *para*-nitrophenetole in 91.4 per cent. yield (m.p. 58.5° C.)

It is seen that the results of Richardson were reproducible and the substitution of caustic soda for potash does not materially lower the yields.

In an effort to shorten the heating time of 140 hours prescribed by Richardson and to improve the yield, a study was made of the influence of various catalysts on the conversion of nitrochlorobenzenes to the anisoles and phenetoles. The proportion of alcohol to the nitrochlorobenzene is very large in Richardson's procedure. In the experiments conducted, the proportion of alcohol was halved. Thus in a typical experiment, 12 gms. *ortho*-nitrochlorobenzene in 200 c.c. of 0.5 N aldehyde-free methyl alcohol was heated at 60° C. in a thermostat. The progress of the reaction was followed by withdrawing 5 c.c. at suitable intervals and titrating with standard acid. When a constant value was obtained, the reaction was considered finished. Over 60 experiments were conducted with *ortho*- and *para*-nitrochlorobenzene, with the

addition of catalysts like cobaltic oxide, vanadium pentoxide, ceric sulphate, antimony oxide, thorium oxide, titanium oxide, selenium dioxide, tungsten oxide, etc., alone and in the presence of manganese dioxide. It was found that the catalysts were of no value in shortening the duration of the reaction or in improving the yield.

In a further series of experiments conducted at 60° C. without stirring, the effect of increasing the alkali concentration to 0.8 N was studied. In the case of phenetoles, the effect was negligible, but in the case of anisoles, the duration of heating was cut down by nearly 50 hours and the anisoles were obtained in good yields and high purity.

The results obtained by carrying out the conversion at the boiling temperature of alcohol in the presence of several catalysts are given in Table II. It may be considered that in these experiments there would be intimate contact between the reactants and the catalysts due to the ebullition. However, the yields obtained were generally unsatisfactory and by-products like dichloroazoxy benzene were formed in large amounts.

A study of the conversion of nitrochlorobenzenes was then conducted in a vessel provided with arrangements for stirring and reflux. The results obtained in this study are given in Tables III—VIII.

TABLE II. Conversion of *para*-nitrochlorobenzene to *para*-nitrophenetole at the Boiling Temperature of Alcohol for 30 hours.

12 gms. of *p*-nitrochlorobenzene were used except in the case marked*

Catalyst	Volume and strength of alkali	<i>Para</i> -nitrophenetole gms.	Per cent. yield
12 gms. MnO ₂ and 1 gm. V ₂ O ₅	200 c.c., 0.5 N	6.3	49.5
12 gms. MnO ₂ and 1 gm. V ₂ O ₅	200 c.c., 1.667 N/2	6.7	50.3
*12 gms. MnO ₂ and 1 gm. V ₂ O ₅	200 c.c., 0.5 N and 8 gms. of nitro compd.	6.0	70.8
12 gms. MnO ₂ and 1 gm. SeO ₂	200 c.c., 0.5 N	9.0	72.4
12 gms. MnO ₂ and 1 gm. Ce ₂ (SO ₄) ₃	200 c.c., 1.667 N/2	9.0	72.4
12 gms. MnO ₂ and 1 gm. Ce ₂ (SO ₄) ₃	335 c.c., 0.5 N	6.4	50.3
12 gms. MnO ₂ and 1 gm. Co ₂ O ₃	6.6 gms. NaOH in 200 c.c. alcohol	5.1	40.1
Blank	200 c.c., 0.5 N	5.9	46.4

TABLE III. Conversion of *para*-nitrochlorobenzene to *para*-nitrophenetole.

20 gms. of *para*-nitrochlorobenzene, 11 gms. of sodium hydroxide, 400 c.c. of aldehyde-free alcohol (95 per cent.), stirring and boiling for 15 hours.

Catalyst	<i>Para</i> -nitrophenetole gms.	Per cent. yield	Melting point ° C.
20 gms. MnO ₂ and 0.2 gms. Co ₂ O ₃	17.7	83.4	58.5
20 gms. MnO ₂ and 1 gm. V ₂ O ₅	17.0	80.1	58.5
20 gms. MnO ₂ and 1 gm. Ce ₂ (SO ₄) ₃	17.6	83.0	59.0
20 gms. MnO ₂ and 0.2 gms. Co ₂ O ₃	18.1	85.3	59.0
20 gms. MnO ₂ and 0.2 gms. Co ₂ O ₃ and 11 gms. lime	18.0	84.9	59.0
20 gms. MnO ₂ and 1 gm. SeO ₂	19.0	90.0	59.0
20 gms. MnO ₂ and 1 gm. WO ₃	11.3	53.3	53.0
20 gms. MnO ₂ alone	19.2	90.5	59.0

TABLE IV. 11 gms. sodium hydroxide in 308 c.c. of aldehyde-free alcohol (95 per cent.), 20 gms. of *para*-nitrochlorobenzene, boiling and stirring for 15 hours.

Catalyst	<i>Para</i> -nitrophenetole gms.	Per cent. yield	Melting point ° C.
20 gms. of MnO ₂ and 0.2 gms. Co ₂ O ₃	18.8	88.7	59
20 gms. of MnO ₂ and 0.2 gms. Co ₂ O ₃	18.9	89.2	59
20 gms. of MnO ₂ and 1 gm. SeO ₂	18.7	88.2	58
20 gms. of MnO ₂ alone	18.7	88.2	58.5
20 gms. of MnO ₂ alone	18.9	89.2	59

TABLE VA. 20 gms. of *para*-nitrochlorobenzene, 11 gms. sodium hydroxide, 308 c.c. of ordinary 95 per cent. alcohol, boiling and stirring for 15 hours.

Catalyst	<i>Para</i> -nitro phenetole gms.	Per cent. yield	Melting point ° C.
20 gms. MnO ₂ and 0.2 gms. of Co ₂ O ₃	19.4	91.1	59
20 gms. MnO ₂ and 1 gm. Co ₂ O ₃	19.0	89.6	59
20 gms. MnO ₂ and 1 gm. SeO ₂	19.3	91.0	59
20 gms. MnO ₂ and 2 gms. V ₂ O ₅	19.3	91.0	59
20 gms. MnO ₂ and 1 gm. Ce ₂ (SO ₄) ₃	19.3	91.0	59
20 gms. MnO ₂ alone	19.1	90.1	59
20 gms. Fe ₂ O ₃	5.7		
10 gms. Co ₂ O ₃	4.5		

TABLE VB. 25 gms. of *para*-nitrochlorobenzene in 250 c.c. of 95 per cent. alcohol, boiling and stirring for 15 hours.

Catalyst	Amount of NaOH gms.	<i>Para</i> -nitro phenetole gms.	Per cent. yield	Melting point ° C.
2.5 gms. Cu ₂ Cl ₂ and 1 gm. glycerol	10	23.1	87.2	58
2.5 gms. Cu ₂ Cl ₂ and 1 gm. glycerol	14	23.6	89.0	59

TABLE VI. Conversion of *ortho*-nitrochlorobenzene to *ortho*-nitrophenetole.
20 gms. of *ortho*-nitrochlorobenzene, 11 gms. sodium hydroxide, boiling with stirring for 15 hours.

Catalyst	Volume of 95% alcohol c.c.	<i>Ortho</i> -nitro phenetole gms.	Per cent. yield
20 gms. of MnO ₂ and 0.2 gms. Co ₂ O ₃	408*	18.4	86.7
20 gms. of MnO ₂ and 1 gm. V ₂ O ₅	408*	18.0	84.9
20 gms. of MnO ₂ and 1 gm. Ce ₂ (SO ₄) ₃	408*	17.0	80.1
20 gms. MnO ₂ alone	408*	18.0	84.9
"	308*	17.7	83.0
"	308	16.6	78.3
"	408	18.4	86.7

* Indicates that aldehyde-free alcohol was used.

TABLE VII. Conversion of *para*-nitrochlorobenzene to *para*-nitroanisole.
20 gms. of *para*-nitrochlorobenzene, 11 gms. of sodium hydroxide, boiling and stirring.

Catalyst	Volume of 95% methanol c.c.	No. of hours	<i>Para</i> -nitro anisole gms.	Per cent. yield	Melting point ° C.
20 gms. MnO ₂ and 0.2 gms. Co ₂ O ₃	408	15	17.2	88.5	48
20 gms. MnO ₂ and 1 gm. V ₂ O ₅	408	20	18.3	94.2	52
20 gms. MnO ₂ and 1 gm. Ce ₂ (SO ₄) ₃	408	20	18.0	92.7	52
20 gms. MnO ₂ and 0.2 gms. Co ₂ O ₃	308	20	18.2	93.7	53
20 gms. MnO ₂ and 1 gm. V ₂ O ₅	308	20	18.4	94.7	53
20 gms. MnO ₂ only	308	20	18.4	94.7	53
	308	15	18.7	96.3	52
10 gms. MnO ₂ only	200	15	18.8	96.6	53.5

TABLE VIII. Conversion of *ortho*-nitrochlorobenzene to *ortho*-nitroanisole.
20 gms. of *ortho*-nitrochlorobenzene in 95 per cent. methyl alcohol.

Catalyst	Time Hrs.	Concentration of alkali	<i>Ortho</i> -nitro anisole gms.	Per cent. yield
20 gms. MnO ₂ , 0.2 gm. Co ₂ O ₃	15	11 gms. NaOH, 408 c.c.	18.2	93.4
20 gms. MnO ₂ , 1 gm. Ce ₂ (SO ₄) ₃	20	"	17.1	88.1
20 gms. MnO ₂ , 1 gm. V ₂ O ₅	20	"	17.6	90.6
20 gms. of MnO ₂ alone	20	11 gms. NaOH, 308 c.c.	17.7	91.1
20 gms. MnO ₂ , 0.2 gm. Co ₂ O ₃	20	"	17.7	91.1
20 gms. MnO ₂ , 1 gm. Ce ₂ (SO ₄) ₃	20	"	17.4	89.6
20 gms. MnO ₂ , 1 gm. V ₂ O ₅	20	"	18.0	92.6
5 gms. MnO ₂ 0.2 gm. Co ₂ O ₃	20	11 gms. NaOH, 120 c.c.	16.3	83.9
10 gms. MnO ₂ alone	15	11 gms. NaOH, 200 c.c.	17.6	90.6
"	20	"	17.8	92.0

From this study the following conclusions could be drawn :—

1. Nitroanisoles and nitrophenetoles can conveniently be prepared in high yields in the presence of suitable catalysts at the boiling temperature of the alcohols if stirring is employed.

2. Operating according to Aoyama's procedure, using manganese dioxide and cobaltic oxide as the catalyst, *para*-nitrophenetole is obtained in 91.1 per cent., *para*-nitroanisole in 93.7 per cent. and *ortho*-nitroanisole in 83.9 per cent. yields.

3. Manganese dioxide alone without the addition of cobaltic oxide yields equally good results. The use of cobaltic oxide is superfluous. The addition of tungsten oxide to manganese dioxide reduces the yield and leads to a very impure product.

4. Ordinary alcohol of 95 per cent. strength can be used for effecting the conversions. Special pre-treatment of distilling over *meta*-phenylenediamine hydrochloride for removing aldehyde as recommended in Richardson's procedure is unnecessary when manganese dioxide is employed as the catalyst.

5. Working under ordinary pressure, *para*-nitrophenetole can be prepared in 90 per cent. yield, using 2.15 mols. caustic soda in 0.89 N solution in 95 per cent. alcohol by stirring and boiling in the presence of 100 per cent. of manganese dioxide for 15 hours.

6. Similarly, *ortho*-nitrophenetole can be prepared in over 85 per cent. yield using 0.67 N solution of caustic soda in 95 per cent. alcohol. Higher alkali concentration lowers the yield.

7. *Para*-nitroanisole can be prepared in 94 per cent. yield by heating for 20 hours with 2.15 mols. caustic soda in 0.89 N solution in 95 per cent. methyl alcohol and using 100 per cent. of manganese dioxide. A heating period of 15 hours gives a less pure product, but by employing 2.15 mols. of caustic soda as 1.37 N solution in 95 per cent. methyl alcohol, and using only 50 per cent. of manganese dioxide, excellent results are obtained both in regard to yield and purity by heating and stirring for 15 hours.

8. Similar considerations apply in the conversion of *ortho*-nitrochlorobenzene to *ortho*-nitroanisole. By heating for 20 hours with 0.89 N caustic soda, a yield of 91.1

per cent. is obtained and by heating for 15 hours with 1.37 N caustic soda solution a yield of 92 per cent. is obtained. According to Aoyama's procedure, the yield of *ortho*-nitroanisole obtained is only 83.9 per cent.

9. By using cuprous chloride and glycerol as catalyst, according to the German patent⁹, *para*-nitrophenetole is obtained in nearly 90 per cent. yield by heating for 15 hours under ordinary pressure. In the patent specification, heating under pressure is recommended but this is not necessary. The catalyst cannot, however, be recovered and used over again.

Several large-scale experiments were then conducted on the conversion of *para*-nitrochlorobenzene to *para*-nitrophenetole. In a typical experiment, conducted in a jacketed cast iron vessel fitted with anchor type stirrer, condenser, etc., 600 gms. of *para*-nitrochlorobenzene were refluxed with stirring with 600 gms. of manganese dioxide in 9 litres of 95 per cent. ethyl alcohol and 330 gms. of caustic soda. 555 gms. of *para*-nitrophenetole were obtained with a melting point of 59° C. (87 per cent. of the theory). From the results of the studies detailed above, it is clear that the conversion of nitrochlorobenzenes to the nitroanisoles and phenetoles using manganese dioxide as a catalyst is the most suitable for adoption on a technical scale, for the following reasons :—

1. The equipment required and the procedure are simple and the reaction can be carried out conveniently in an ordinary cast iron jacketed vessel.

2. The products are obtained in a high state of purity and in excellent yields and there are no by-products like dichloro-azoxybenzene.

3. The duration of the reaction is short, lasting only 15 hours, under ordinary pressure. Richardson's procedure involves heating for 140 hours and the procedure of Groggins nearly 60 hours.

4. The catalyst is cheap and can be recovered and used over and over again (*c.f.*, Groggins).

5. Ordinary alcohol of 95 per cent. strength yields excellent results (compare Richardson).

Experimental

Nitration of Chlorobenzene.—The optimum conditions for the mono-nitration of chlorobenzene were determined by Dey, *et al*¹². The large-scale nitrations were

carried out in a jacketed cast iron vessel of 10 gallons capacity provided with a sleeve and conveyor type of agitator. A mixed acid of D.V.S. 5 was employed at a nitration temperature of 50° C. In two runs the following results were obtained:—

No.	Chloro-benzene gms.	HNO ₃ d, 1.52	H ₂ SO ₄ d, 1.835	Wt. of para compound at ord. temp. gms.	Wt. of ortho and para liquid gms.	Total gms.	Per cent. yield
1	13,810	5216	10,350	8115	10,563	18,678	96
2	13,810	5216	10,350	7950	10,405	18,355	94

The 20,968 gms. of the combined liquid portions gave on cooling to 16° C. a further 2,775 gms. of *para* compound. The eutectic mixture, 17,805 gms. was submitted to a series of four fractional crystallizations and fractional distillations (through a Raschig column, in vacuo) gave 7,164 gms. of *ortho*-nitrochlorobenzene* and 4,359 gms. of *para*-nitrochlorobenzene. The rest was an eutectic mixture which was mixed with a further batch and fractionated.

Conversion of para-nitrochlorobenzene to para-nitrophenetole according to the method of Groggins.—The experiment was carried out in a 20-litre jacketed cast iron vessel fitted with an anchor type stirrer and condenser. The procedure described by Groggins was scrupulously followed. Groggins prescribed that the reaction mass should be filtered at the end of 52 hours; however, according to our experience, large amounts of dichloroazoxy benzene were found in the reaction mass at this stage and the filtration could not be effected without removing this compound also along with the potassium chloride. After filtration, the reaction was continued by heating with an additional amount of potassium sulphite for 3 more hours. The reaction mass was then neutralized with sulphuric acid, filtered to remove dichloroazoxybenzene and the alcohol distilled off. The residue was treated with water, and the solid mass obtained, triturated in a mortar with dilute sodium hydroxide solution to remove nitrophenol. The *para*-nitrophenetole was then filtered, washed with water and dried in air.

Conversion of Nitrochlorobenzene to Nitroanisoles and Nitrophenetoles.—The following

procedure was adopted in carrying out the experiments listed in Tables III—VIII.

The experiments were conducted in a litre bolt-head flask, fitted with a stirrer (mercury seal), and a condenser and set in a heated water bath. After conducting the

experiment with the quantities and for the duration indicated, the alcohol solution was first filtered hot from the catalyst. In some cases where dichloroazoxybenzene was formed, this was removed along with the catalyst during filtration. The filtrate was neutralized with 4 N sulphuric acid and the alcohol then distilled off.

In the case of solids, the residue was ground with dilute alkali to remove nitro phenol, the product filtered, washed with water and dried in air. In the case of liquids, the reaction product was extracted with ether, the extract washed with alkali and water and the ether then distilled off.

Our grateful thanks are due to the Council of Scientific and Industrial Research for a grant which defrayed the expenses of this investigation and for kind permission to publish the results.

References

- 1 Heumann, *Ber.*, 1872, 5, 910.
- 2 Willgerodt, *Ber.*, 1879, 12, 767; 1882, 15, 1002.
- 3 Blom, *Helv. chim. acta*, 1921, 4, 297.
- 4 Richardson, J.C.S., 1926, p 522; *J.S.C.I.*, 1926, 45, 200T.
- 5 *National Aniline and Chemical Company, E.P.* 239,320 (1925).
- 6 McCormack and Stockman, *Ind. Eng. Chem.*, 1939, 31, 278.
- 7 Riklis, *Org. Chem. Ind. (U.S.S.R.)*, 1940, 7, 154.
- 8 Clemmensen, *U.S.P.* 1,875,916.
- 9 *D. R. P.*, 453,429.
- 10 Groggins, *Unit Processes in Organic Synthesis*, (1935), 467.
- 11 Aoyama and Kizonanai, *J. Pharm. Soc. (Japan)*, 1933, 53, 613; *Bull. Imp. Hyg. Lab. (Tokyo)*, 42, 235.
- 12 Dey, Govindarajan, and Govindachari, *J. Sci. Ind. Res.*, 1944, 3, 95.

BIOCHEMICAL STUDIES IN FUNGI

PART I.—ACID AND ANTIBIOTIC PRODUCING CAPACITIES OF SOME *ASPERGILLI*

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A SYSTEMATIC study of the collection of *Aspergilli* maintained by the National Collection of Type Cultures, India, has been undertaken with a view to determine their biochemical performance, their capacity to produce an acid or an antibiotic when cultured on a standard medium. In an earlier communication¹, the antibiotic producing capacity of a few strains of *Aspergilli* was described. The work has now been extended to the remaining portion of the type cultures.

The cultures employed in this work represent isolations from single spores, thereby ensuring the integral purity of the organisms. The isolations were accomplished by the dilution plating method; high dilutions of the spore suspension were employed and the single spore was located in the plate by microscopic observation. The plates were then incubated at 28° C. and the development of the single spore was frequently examined until definite clearly spaced colonies were seen. Such single spore colonies were transferred in a sterile chamber on to slants and incubated for a further period at 28° C.

Incidentally, these isolations have facilitated the study of the developmental stages such as vegetative growth and fruiting, the characteristic of the colony and its colour, etc. Spores resulting from such single colonies have been used for the studies described in this paper.

Material and Method

Since the investigation as planned involved the study of a large number of strains, it was essential that a simple and more economical method of experimentation should be evolved. After a number of trials, the following method was found to be the most suitable which, not only facilitated the maintenance of specific conditions of growth, but also secured reproducibility of results.

Bacteriological test-tubes 150 mm. long and 17 mm. in diameter were first selected,

sterilized and 5 cc. of media (liquid) transferred to the tubes. The medium was then sterilized in test-tubes and inoculated with 0.1 cc. of a suspension containing approximately 8 to 8.5 million spores per cc.; as revealed by a count of the suspension by means of a hæmacytometer. The tubes were placed in a slanting position at an angle of 24° to 30° in racks. This arrangement secured the necessary surface and conditions of adequate aëration for the growth of the fungus. The tubes were incubated at 28° C. for 9 days. At intervals of 48 hours, growth characters and the time and intensity of sporulation, were noted.

Acid Production

The standard medium (Curie's) was used for the purpose; a pH. range of 3.5 to 3.8 was maintained by the addition of dilute HCl to previously sterilized medium to prevent inversion.

The medium was composed of:

Sucrose ..	150 gm.
NH ₄ NO ₃	2.5 gm.
KH ₂ PO ₄ ..	1.0 gm.
MgSO ₄ , 7H ₂ O	0.25 gm.
Water ..	1,000 cc.

After completion of the period of incubation, the tubes were autoclaved at 5 lbs. for 30 minutes. The cultures were filtered and the filtrate in all the cases made up to 50 cc.; 10 cc. aliquots of the solution were titrated with N/10 NaOH with phenolphthaleine as the indicator.

Residual sugar in the filtrate was estimated by the micromethod of Shaffer and Hartmann². The sugar in the control tube was also determined after inversion. The results are given in Table I; the acid is expressed as citric acid, 1 cc. of the decinormal alkali being equivalent to 7 mgm. of the acid.

TABLE I.

Percentage of sugar in the original medium, 14.9.

Culture No. N.C.T.C.	560	561	562	563	564	565	566	567	568	569	570	571
Percentage of citric acid produced on the basis of sugar consumed.	26.9	25.9	30.0	23.9	38.2	27.3	9.6	6.4	3.9	3.5	6.3	8.7
Percentage of residual sugar.	4.9	5.4	4.6	4.6	5.8	5.8	11.2	7.1	8.7	7.8	9.0	4.5
Culture No. N.C.T.C.	572	573	574	575	576	577	578	579	580	581	582	583
Percentage of citric acid produced on the basis of sugar consumed.	22.1	19.1	19.8	23.0	31.0	36.6	11.5	13.7	30.7	27.8	7.5	25.1
Percentage of residual sugar.	5.2	3.7	5.6	3.9	3.1	4.0	3.8	6.6	5.9	5.5	7.5	6.0

Antibiotic Activity

The 24 strains investigated for acid production were also studied for their antibiotic producing capacity. The method of inoculation and the conditions of growth and incubation were the same as described before; the medium used for the purpose had the following composition.

Glucose	..	..	40	gms.
NaNO ₃	..	..	3	gms.
KH ₂ PO ₄	..	..	1	gm.
MgSO ₄	..	..	0.5	gm.
FeSO ₄	..	..	0.01	gm.
KCl	..	..	0.5	gm.
Water	..	..	1,000	cc.
pH	..	..	6.8.	

After the period of growth, the liquid was filtered, and the pH of the filtrate was noted in each case and neutralized to pH 6.8 by the addition of decinormal alkali. The test organism employed was *Staphylococcus aureus*, N.C.T.C. No. 2153, and the standard cup-assay method was adopted³ for measuring the antibiotic activity of the filtrates. The results are given in Table II.

five show promise of yielding acid (above 30 per cent.) in appreciable quantities; it is expected that these five strains could be made to give a better performance by altering the composition of the medium. In two instances, Culture Nos. N.C.T.C. 564 and 570, yields of acid have respectively amounted to 38.2 and 36.6 per cent. on the weight of the sugar consumed. High acid yielders are characterized by light yellow coloured colonies, black spores, and light yellow coloured filtrates. None of the *Aspergilli*, have shown any antibiotic activity; they are essentially acid producers, shifting the reaction of the medium to the acid side; it is generally recognized that fungi of this type do not produce any antibiotic.

In conclusion, we wish to express our grateful thanks to Sir J. C. Ghosh for the kind interest he has taken in the course of these investigations and to the *Council of Scientific and Industrial Research* for their generous support.

References

- 1 Ramachandra Rao, T. N., and Iya, K. K., *J. Sci. Ind. Res.*, 1945, 3, 510.

TABLE II.

Original pH of the medium 6.8; Test organism used, *Staphylococcus aureus*, N.C.T.C. 2153; Temp. 37° C.

Group characters.	Bright yellow coloured colonies, heavy blackspores on the fourth day. Colour of the filtrate, light-yellow.						White-bluish grey colonies, producing black coloured spores on the 4th day. Filtrate colourless.					
N.C.T.C.	560	561	562	563	564	565	566	567	568	569	570	571
pH after fermentation	4.8	4.8	4.8	5.0	4.8	4.8	3.4	3.2	3.8	3.1	3.2	3.8
Antibiotic activity	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Group characters.	Yellow colonies, producing black coloured spores on the 3rd day. Colour of the filtrate, very light-yellow.						Radial type, white colonies with yellowish tint sporulating on the 4th day. Filtrate, colourless.					
N.C.T.C.	572	573	574	575	576	577	578	579	580	581	582	583
pH after fermentation	4.6	4.6	4.5	4.6	4.6	4.6	3.1	3.1	4.6	3.1	3.1	4.6
Antibiotic activity	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.

Discussion and Summary

It will be seen from the tables that of the 24 strains of the *Aspergilli* investigated, only

² *J. Bact.*, 1926, 12, 427.

³ Abraham Chain, Fletcher, Gardner, Heatley, Jennings and Florey, *Lancet*, 1941, p. 177-189.

BIOCHEMICAL STUDIES IN FUNGI

PART II.—ANTIBIOTIC PRODUCING CAPACITY OF SOME *PENICILLIA*.

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THE present communication relates to a study of the antibiotic producing capacity of 27 cultures of *Penicillia*, maintained by the National Collection of Type Cultures, India.

The cultures represent single spore isolations and the experimental technique employed in these studies is similar to that described in our previous communication². After sporulation, a known quantity of spore suspension (0.1 cc.) was transferred to 5 cc. of nutrient liquid medium (composition:—Glucose, 40 gms.; NaNO₃, 3 gms.; KH₂PO₄, 1 gm.; MgSO₄, 0.5 gm.; FeSO₄,

0.01 gm.; KCl, 0.5 gms.; Water, 1,000 cc. pH. 6.8). The tubes were inoculated in duplicates and incubated at 28° C. for 9 days on wooden racks at an angle of 30° to secure a large surface for the growth of the fungus. The reaction of the medium after growth was adjusted to pH 7.0.

Antibiotic Activity

The antibiotic activity of the filtrates was tested against *Staphylococcus aureus*, N. C. T. C. 2153, by the cup-assay method described in an earlier paper¹. The results are shown in Table I.

TABLE I.

Original pH. 6.8; Test organism, *Staphylococcus aureus* (N.C.T.C. No. 2153); Temp. 37°.

Culture N.C.T.C. No.	Colony characters.	pH. after 9 days' incubation at 28° C. and colour of the filtrate.	Antibiotic activity.
1536	Light green colony, growth sparse, sporulates on the 4th day.	Greenish yellow	No clearance.
1537	Round green centrally raised, folded, sporulates on the 4th day.	7.1 Straw yellow	17 mm.
1538	Concentric rings depressed in the centre and thin white margin.	6.4 Light yellow.	No clearance.
1539	Light green with a thin white margin all round.	6.0 Deep fluorescent yellow.	19 mm.
1540	Green in centre surrounded by a broad white margin.	5.9 Yellow.	22 mm.
1541	Central portion dark green, dull green all round.	6.6 Yellow.	21 mm.
1542	Green coloured felty growth, sporulates on the 4th day.	4.6 Fluorescent yellow.	20 mm.
1543	Starts as white colony, later develops green spots in the centre and white margin.	4.8 Greenish yellow.	No clearance.
1544	Uniform bright green felty growth and dark green spores.	4.4 Fluorescent green.	20 mm.
1545	Pale green coloured colony interspaced with white spots.	6.0 Greenish yellow.	No clearance.
1546	Light green velvety colony and green colour intensifies up to 6th day.	7.3 Light pale yellow.	23 mm.
1547	Bluish green wrinkled spreading colony, remains light green till 6th day.	7.1 Bright yellow.	16 mm.
1548	Starts as white spots, attains green colour on the 4th day.	7.4 Pale yellow.	19 mm.
1549	White raised highly folded colony with spots of green.	7.6 Pale yellow.	No clearance.
1550	Centrally raised light green coloured felt like colony.	7.3 Greenish yellow.	17 mm.
1551	Colony white, poor growth, margin irregular.	5.3 Dark brown.	No clearance.
1552	Dull green wrinkled centrally raised colony, sporulated on the 4th day.	7.5 Fluorescent yellow.	20 mm.
1553	Spreading white marginated folded, later producing green colour colony.	8.2 Fluorescent yellow.	20 mm.
1554	Pale green highly grained type of growth.	7.8 Dark brown.	17 mm.
1555	Bright green centrally raised white marginated colony.	6.9 Dark yellow.	No clearance.
1556	Bluish green centrally raised white marginated colony.	4.0 Deep yellow.	No clearance.
1557	Bright green centrally raised felty type colony.	6.7 Greenish yellow.	17 mm.

TABLE I—continued

Culture N.C.T.C. No.	Colony characters.	pH. after 9 days' incubation at 28° C. and colour of the filtrate.	Antibiotic activity.
1558	Dull green uniform growth and no white margin.	6.5 Pale yellow.	No clearance.
1559	Dull green with white spots and poor growth.	4.0 Greenish yellow.	No clearance.
1560	Highly grained, centrally raised dull green colony.	5.0 Light yellow.	16 mm.
1561	Dull green colour with white spots.	4.2 Light yellow.	No clearance.
1562	Bright green colour with interspaced white spots.	4.0 Greenish yellow.	No clearance.

It was observed that from among 27 *Penicillia* studied so far, 12 have failed to show any clearance.

Conclusions

It will be seen from the table that *Penicillia* which yield the antibiotic, (1) show characteristic colonies with a light green colour which deepens uniformly as the growth proceeds, and (2) shift the reaction of the medium after growth of the fungus to a pH. above 7.0. The colour of the filtrate does not appear to bear any relation to its antibiotic activity. Such of those green colonies which on developing show a dullness of colour, and those that develop the green

colour only in spots, may be taken to represent strains which do not yield any antibiotic.

In conclusion, we wish to express our grateful thanks to Sir J. C. Ghosh for the kind interest he has taken in the course of these investigations, and to the *Council of Scientific and Industrial Research* for their generous support.

References

- 1 T. N. Ramachandra Rao & K. K. Iya, *J. Sci. Ind. Res.*, 1945, 3, 510.
- 2 T. N. Ramachandra Rao, Rama Mohan & M. Sreenivasaya, *J. Sci. Ind. Res.*, 1945, 4, 375.

PILOT PLANT FOR THE RECOVERY OF TITANIUM DIOXIDE FROM BAUXITE SLUDGE

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THOUGH ilmenite constitutes the usual raw material for the manufacture of TiO_2 , the Indian bauxite ores which are in general richer in titanium than the foreign ores¹, containing on an average 10 per cent. TiO_2 , have also attracted attention. Bauxite deposits containing as high as 14 per cent. titanium dioxide have also been reported². In view of the high titanium content of the

Indian ores, the sludge that remains after the extraction of aluminium either as sulphate (as commercial alumina-ferrie) or alumina (as in Bayer's process) is rich in TiO_2 and constitutes a valuable source for its recovery. Table I gives the results of analyses of the ore and the sludge or red mud that is left over in both the processes.

In general, the sludge represents in either

TABLE I

Description	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	SiO_2 %	Remarks.
Original bauxite (Ranchi)	55.8	6.7	14.1	0.5	The sludge was obtained by adopting the Bayer's process of extracting aluminium: the figures were supplied by the Aluminium Corporation Co., Asansole.
Sludge or red mud	12.4	20.5	46.8	2.2	
Original bauxite (Katni)	62.3	3.6	9.78	1.29	The sludge was obtained after the removal of aluminium as sulphate with sulphuric acid.
Sludge	20.4	1.1	33.4	10.6	
Sludge (obtained from Bengal Chemical and Pharmaceutical Works).	23.2	5.3	30.9	16.4	

of the processes about 40 per cent. of the original bauxite ore. At a conservative estimate, the titanium dioxide that could be recovered from both these types of waste products would amount to about 2,000 tons and would meet the internal demands for titanium whites for pigment purposes.

The general problem of manufacture of titanium dioxide is well known³. Various attempts have been made in India⁴⁻⁶ to recover titanium dioxide from waste sludge. Experiments have been in progress for some time in these laboratories, and a scheme was sanctioned⁷ in 1943 for investigating the problem on a pilot plant scale.

Experimental

A pilot plant with a production capacity of 20 lbs. of TiO_2 per day has been designed and constructed in the departmental workshops. The general method employed is similar to that in which titanium is extracted from ilmenite and described elsewhere⁴. The air-dry sludge (90 lbs.) is treated in a lead-lined vessel (see Fig. 1 'D', size: 3' x 2' dia.) with sulphuric acid (sp. gr. 1.4, 40 lbs.) and the temperature raised to 80-90°C. The heating was effected by circulating the flue gases (see Fig. 1 (b)) from the furnaces, used for heating the hydrolysis vessels. The operation takes about two hours and results in the removal of most of the iron and aluminium. Higher concentrations of sulphuric acid were found to extract the titanium also resulting in lower yields. The residue which is rich in titanium oxide (cf. Table II) is thoroughly washed with water till faintly acid, and dried in brick enclosures (8' x 5½'). The dry mud (50 lbs.) thus prepared, is then mixed with sulphuric acid (sp.gr. 1.8, 90 lbs.) and heated at 250-300° C. in a muffle furnace provided with acid-resisting floor and raking arrangement.

TABLE II

	Before treatment	After treatment
Al_2O_3 %	23.2	18.6
Fe_2O_3 %	5.3	1.3
TiO_2 %	30.9	49.2
SiO_2 %	16.4	19.1

The digestion is complete in about 4 hours, as is shown by the dense white fumes coming out. The reaction mass which is friable and soft, is then dissolved in weak acid (sp.gr. 1.2, 20 lbs.) or in the mother liquor

that comes from the hydrolysis stage. The resulting solution of titanium sulphate, containing ferric sulphate as impurity, is allowed to settle in big storage tanks (No. 4; capacity 8 gallons) with sloping sides to facilitate settling. Milk of lime was added at this stage to facilitate flocculation and also to decrease the free acid content. The supernatant clean liquor is drawn off into another series of vessels, similar to the settling tanks, where the Fe^{+++} is reduced to Fe^{++} by adding clean scrap iron (1 lb.). This reduction of ferric iron into the ferrous stage is very essential as it is known that iron in the ferric state has a tendency to precipitate as hydroxide even in acid solutions.⁸ The solution was tested at different stages for the Fe^{++} iron with ammonium thiocyanate solution. But with experience the solution can be judged for complete reduction by the violet colour that is imparted to the solution by the titanous ions. The reduced solution is then diluted with water till the free acid content per litre corresponds to 10 per cent. and then taken for hydrolysis.

The hydrolysis is the most important stage of the operations, as it affects the pigmentative properties of the titanium dioxide that is produced. There are a large number of references particularly to patent literature, for obtaining TiO_2 in the maximum yields and of the required particle size. The determination of the optimum TiO_2 : SO_3 ratio⁹ for the maximum precipitation, the use of 'seeding nuclei' for precipitation of titanium dioxide of greater opacity¹⁰, the use of a protective colloid like dextrin, in the presence of bivalent ion during hydrolysis¹¹ to prevent the simultaneous precipitation of iron, are some of the main lines of investigation.

After several trials, the following procedure was adopted. The clean sulphate liquor is drawn into the hydrolysis vessels made of mild steel and lined with 1/16" lead sheeting (No. 4; size, 1½' x 1½'), and diluted with the necessary amount of water under constant stirring in the cold to induce "autoseeding." It is essential that the temperature should not be raised during this operation. When once the nuclei of the desired size are formed, more of the sulphate liquor is drawn in and the temperature raised to 90°-95° C. After an hour's hydrolysis at this temperature, 15-20 per cent. more of water is added and the temperature

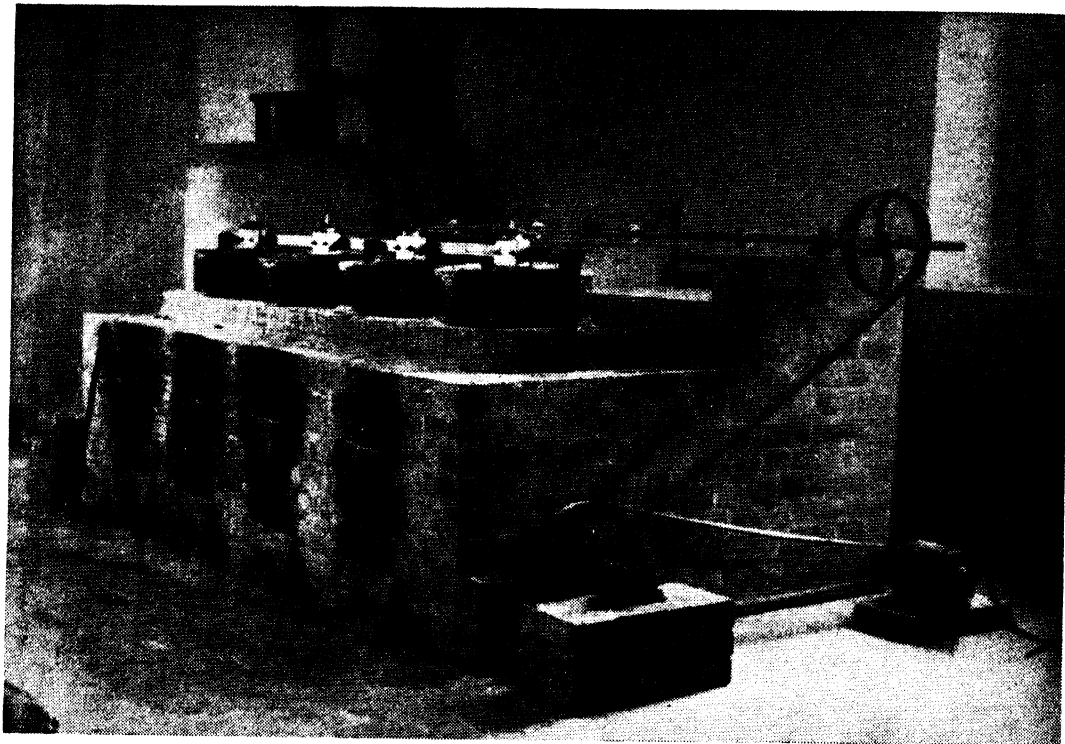


Fig. 1a.

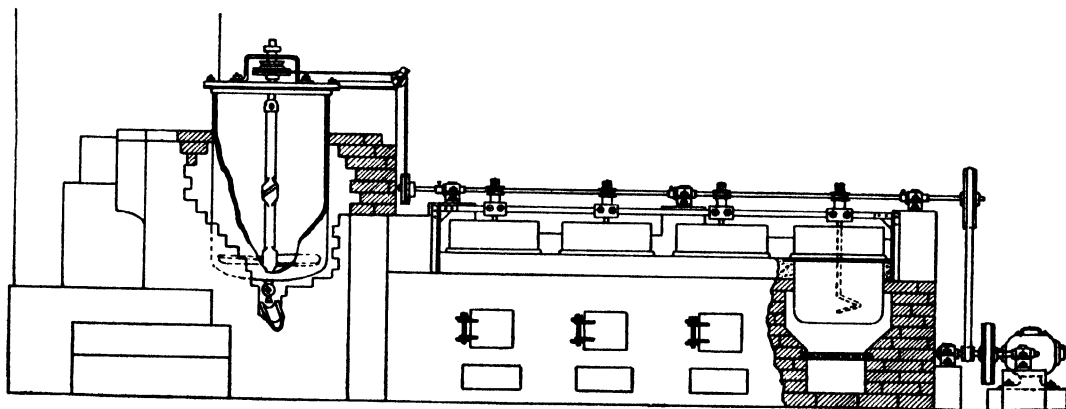
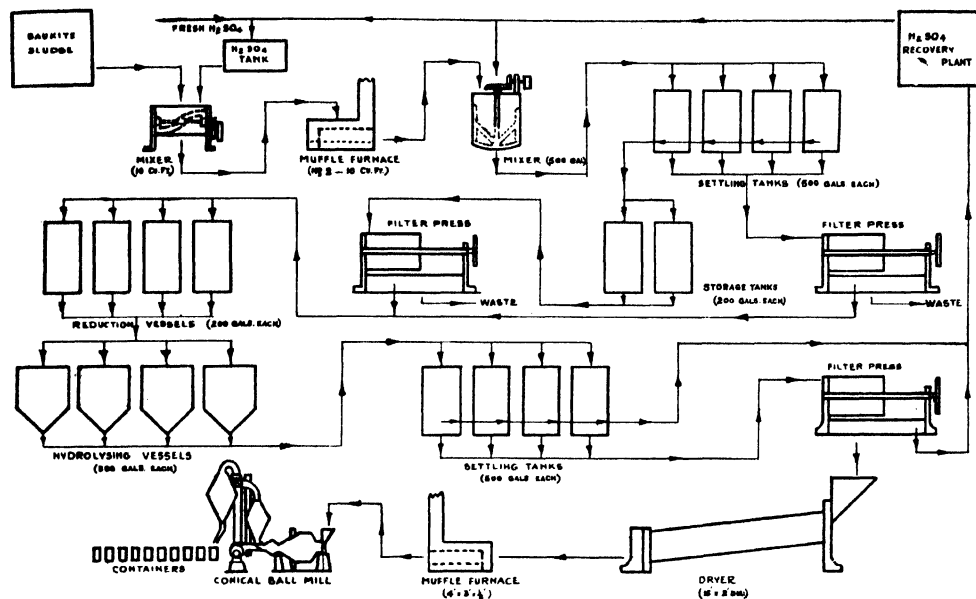


Fig. 1b.

maintained at 95°C . for another hour. By this means the hydrolysis is completed and the whole of the titanium in solution is precipitated as metatitanic acid. During the hydrolysis it was found helpful to use a reducing agent (sodium bisulphite, 1 per cent.) which was effective in keeping the iron in the ferrous condition and prevented its hydrolysis. The metatitanic acid is then

filtered (1st stage) and the filter cake washed free of iron with a 3 per cent. solution of sulphuric acid, filtered (2nd stage) and air-dried. When the product is dry to within 7-8 per cent. moisture, the metatitanic acid is calcined in a rotary kiln, the temperature of the hottest zone of which is kept at 900°C . In the pilot plant set up in these laboratories, the preliminary drying was



FLOW SHEET for THE RECOVERY of TITANIUM DIOXIDE from BAUXITE SLUDGE

Fig. 2.

carried out in an inclined drier, heated by the flue gases and the final calcination in a muffle furnace. In large-scale manufacture, the two stages can be continuous and both drying and calcination may be carried out in a rotary calciner of the type employed in the cement industry. The titanium dioxide finally obtained (19½ lbs., recovery yields, 70.2 per cent.) was fed into ball mills fitted with cyclone separators. An analysis of the TiO_2 obtained is given below:—

H_2O}	..	..	%
TiO_2	..	..	1.14
Fe_2O_3	..	..	98.42
			0.05.

Titanium dioxide of lower iron oxide value can be obtained by using either enamelled or other acid resistant vessels for hydrolysis. Though titanium dioxide of the highest chemical purity was obtained, the product was not altogether comparable to the imported standard titanium whites in its opacity and covering power. Further experiments are in progress to improve the pigment properties.

It has been observed earlier that the mother liquor from the hydrolysis stage containing sulphuric acid, could be utilized to dissolve the titanium sulphate cake from the digestion furnace. After it has been

used a number of times, the solution gets so much concentrated in iron and aluminium that it is no longer advisable to use it to dissolve the digester cakes, but to return it for the recovery of alumina ferric or ferrous sulphate and then recovering the sulphuric acid for recycling in the process.

A part view, showing the hydrolysis vessels and lixiviating tank of the pilot plant set up in these laboratories is shown in Fig. 1 (a); Fig. 1 (b) shows the same in sketch. Fig. 2 gives the flow-sheet of the process, which also gives the number, type and capacity of the equipment required for the production of 1 cwt. of TiO_2 per day.

References

- 1 C. S. Fox, *Bauxite and Aluminous laterite* (Technical Press, London) 1932, pp. 68, 185; Mellor, *A comprehensive Treatise on Inorganic and Theoretical Chemistry*, 1929, 5, pp. 250.
- 2 *Science and Culture*, 1942, 18, 171.
- 3 *Chem. Trade Journal*, 1931, 88, 29; *J. Oil and Colour Chem. Assn.*, 1943, 26, 141; *Paint Manufacture*, 1945, 15, 161, 198.
- 4 *I.R.B. Bulletin*, No. 15, 1939.
- 5 *J. Ind. Chem. Soc., Ind. and News Ed.*, 1941, 4, 16.
- 6 *Trans Ind. Ceramic Soc.*, 1945, 4, 75.
- 7 *J. Sci. and Ind. Res.*, 1943, 1, 235.
- 8 *Chem. Trade J.*, 1931, 88, 29.
- 9 *Ind. Eng. Chem.*, 1933 25, 262; 1937, 29, 213.
- 10 *Ind. Eng. Chem., Anal. Ed.*, 1932, 4, 191; *Brit. Pat. No. 491,541*.
- 11 *U. S. Pat. Nos. 2,028,292 and 2,108,723; Brit. Pat. No. 481,892.*

SOME EXPERIMENTS ON Q-ALLOY

PART I—SEPARATION OF COPPER FROM SILVER

By M. K. BOSE

(His Majesty's Mint, Calcutta)

QUATERNARY alloy—Q-alloy—as used in Indian coinage, has the composition : Ag, 50; Cu, 40; Ni, 5; Zn, 5. A direct electrolytic separation of silver from a nitric acid solution of the alloy, which is the method adopted in the Bombay Mint for separating silver from copper in standard silver alloy (Ag, 91.6; Cu, 8.4), will obviously present many difficulties due to the high percentage of copper which will always tend to get codeposited with silver even if the voltage is kept sufficiently low without seriously affecting the output. A preliminary separation of copper from silver was, therefore, aimed at, and the present paper describes the results obtained in small-scale laboratory experiments.

Silver oxide can precipitate copper oxide from a solution of copper nitrate, silver oxide itself passing into solution as nitrate. Moreover, it was found that for the precipitation of silver as oxide, a pH . higher than 7 was necessary whereas copper could be completely precipitated as a mixture of basic salt and oxide between pH . 6.5 and 7. Therefore, as long as the pH . was below 7 there was very little chance of any silver getting co-precipitated with copper and the traces of silver that was found with copper in the following experiments could, therefore, be safely ascribed to the adsorption of silver by the voluminous precipitate of oxide and basic salts of copper. If the reaction between silver oxide and copper nitrate was assumed to take place in equimolecular proportions, it would be found that silver oxide obtained from, say, 100 parts of Q-alloy, could precipitate copper in another 36 to 37 parts of Q-alloy. But it was found that under the conditions of the experiments, silver oxide obtained from one part of Q-alloy could be made use of to precipitate copper in an equal part of Q-alloy. The only explanation was that under the conditions of the experiments, the reaction between silver oxide and copper nitrate was always attended with other side reactions leading to the formation of insoluble basic salts of copper. The

and particularly of zinc,

which has an amphoteric behaviour, though in small quantities, was also to be taken into account as the oxides of these two metals exert a precipitating influence on copper. In fact, the presence of most of the nickel and zinc in solution along with silver supported the view that these two metal oxides also contributed towards the precipitation of copper. Again, if instead of precipitating a portion of the Q-alloy solution in nitric acid with caustic soda and then adding the remaining half of the solution, the whole portion of the Q-alloy solution was treated with the same amount of caustic soda, complete precipitation of copper could not be effected; an additional quantity of caustic soda equal to that already added, was found necessary and the character of the copper precipitate was different and complete separation was not always certain.

Experimental

The Q-alloy in the form of rolled clippings was dissolved in nitric acid. In the following experiments, a slight excess of acid was used in order to dissolve the entire quantity of the alloy taken, the excess being then either neutralized or boiled off. It would be more economical, however, to keep a little of the alloy always undissolved in the nitric acid taken, so that the acid might be used up as far as possible. In this case, very little caustic soda would be required for the preliminary neutralization, there being practically no unreacted acid left in solution. The solution so obtained was neutralized slowly until a slight precipitate remained undissolved, and it was then diluted to 1 to 3 per cent. strength. The strength of the solution could be varied within wide limits, particularly for larger charges. One half of the solution thus obtained was treated with a 10 per cent. solution of caustic soda until no further precipitation took place, the end of complete precipitation being always marked with a distinct alkaline reaction to litmus. During the addition of caustic soda, it was observed that the brown precipitate of silver oxide that formed,

TABLE I.

Wt. of Q-alloy	Silver solution.			Copper precipitate.				Aver. Composition.			
	Cu	Ni	Zn	Ag	Cu	Ni	Zn	Ag	Cu	Ni	Zn
2	0.0043	0.085	0.080	0.0045	0.714	0.007	0.009	1.0	0.8	0.1	0.1
2	0.0038	0.085	0.079	0.0045	0.721	0.008	0.015	"	"	"	"
2	0.0020	0.094	0.082	0.0040	0.788	0.006	0.016	"	"	"	"
2	0.0117	0.082	0.081	0.0041	0.785	0.014	0.018	"	"	"	"
4	0.0042	0.175	0.160	0.0088	1.591	0.020	0.060	2.0	1.6	0.2	0.2
10	0.0200	0.430	0.392	0.0220	3.625	0.036	0.090	5.0	4.0	0.5	0.5
15	0.1200	0.650	0.590	0.0400	5.680	0.055	0.150	7.5	6.0	0.75	0.75

quickly dissolved with stirring, giving rise to a greenish precipitate of basic salts of copper.

As long as copper nitrate remained in solution, a permanent precipitate of silver oxide was not obtained, the latter quickly passing into solution and precipitating copper. The greenish precipitate gradually became dull and then dirty brown due to the precipitation of silver with further additions of alkali. When precipitation was complete, the solution was boiled for a few minutes, and to the boiling solution the other half of the original solution was added and the boiling continued for another ten minutes. A distinct change in the colour of the precipitate, from dirty brown to ash, was noticed due to the solution of silver oxide in the first half and precipitation of copper in the second half of the solution. The solution was allowed to settle, and when cold, the supernatant liquid containing practically the entire amount of silver in the mixture with most of the nickel and zinc, was filtered off and the precipitated copper washed a few times with water. It was noticed that whereas the first half of the solution showed a distinct alkaline reaction after treatment with caustic soda for complete precipitation of copper and silver, the mixture of the two portions after boiling and cooling, was not alkaline to litmus; in some instances, a faint acid reaction was observed. Complete solution of silver for which a *pH* less than 7 was necessary, was thus ensured. The insoluble copper precipitate could be dissolved in nitric acid and after separating the traces of silver with metallic copper, it could be used straight off in the copper cell. The aqueous portion containing the silver could similarly be used after the addition of the requisite quantity of nitric acid, for the purification of silver in the silver cell. Most of the nickel and zinc present in the Q-alloy together with

traces of copper, will remain in solution after the removal of silver. Excepting the dissolution of the alloy, for which acid-resistant vessels are necessary, all other operations can be carried out in stay-bright steel vessels which are little affected by dilute acids.

The entire amount of caustic soda, though cheap, and an amount of nitric acid equivalent to copper, were lost; the portion of acid equivalent to silver was, recoverable and could be used over again. Some arrangement for the separation of the precipitated solid from liquid (filter press, centrifuge or suction filter) will be necessary for handling larger quantities.

Results

Silver was not estimated in the separated silver solution; only the quantity left with copper was determined. Copper was estimated both in the silver solution and the separated solid. Nickel and zinc were estimated in the silver solution and the copper portion as well. The weights recorded in Table I are in grammes.

It is evident from the above figures that 200 gms. of Q-alloy containing 100 gms. of silver, 80 gms. of copper and 10 gms. each of nickel and zinc would give a silver solution having an average composition—Ag, 99.5 gms.; Cu, 3.8 gms.; Ni, 9 gms.; Zn, 8 gms. and the copper precipitate on solution would contain Cu, 76.2 gms.; Ag, 0.45 gm.; Ni, 6.7 gms.; Zn, 0.8 gm. Recovery of both silver and copper from such solutions is not difficult by the use of the customary electrolytic methods.

The author's thanks are due to Major D. V. Deane, O.B.E., R.E., the Master of the Mint, Calcutta, and to Mr. G. C. Mitter, M.Sc., O.B.E., Chief Assayer, Bombay, for their interest in this investigation and also for permission to publish this paper.

Letters to the Editor

INFLUENCE OF B-VITAMINS ON THE ALCOHOL PRODUCING CAPACITY OF A STRAIN OF DISTILLERY YEAST

WILLIAMS, Mosher and Rohrmann¹ found that pantothenic acid influences in some way the carbohydrate metabolism of yeast, since a definite increase in its glycogen content was observed in presence of the vitamin. Pantothenic acid and thiamin were reported to have a stimulatory effect on the respiration of Gebruder Mayer yeast by Pratt and Williams². Recently, Winkler, Burk and Du Vigneaud³ have shown that biotin increases the rate of respiration and fermentation in yeast. It was of interest to study the role of B-vitamins in the production of alcohol by some of the industrially important strains of brewery and distillery yeasts. The present communication relates to the study of a strain of distillery yeast, *S. cerevisiae* N.C.T.C. No. 3013, which has been found to raise the concentration of alcohol in distillery washes to 12 per cent. by volume.

trifuged and washed four times with 0.9 per cent. saline. Suspensions of equal turbidity were prepared in saline; alcohol producing capacity of these organisms was determined by inoculating the experimental medium with sufficient inoculum to give a 2 per cent. suspension of moist yeast on the weight of sugar. The reaction mixture was incubated for 48 hours at 28° C., the alcohol formed, was determined according to the method of Johnson⁴. Residual sugar was determined by the micro-method of Shaeffer and Hartmann as modified by Stiles, Peterson and Fred⁵. Growth of yeast which might have occurred during the period was measured in a photoelectric turbidometer. The results are given in Table I.

It will be observed that, of the vitamins of the B-complex so far investigated, biotin alone definitely stimulates the production of alcohol; pantothenic acid and pyridoxine appear to increase the production of alcohol to a small extent but the results with inositol appear anomalous in consideration of the fact that alcohol production is decreased in presence of this vitamin. Thiamin does

TABLE I

	Biotin		Pantothenic acid		Pyridoxine		Thiamin		Inositol	
	+	—	+	—	+	—	+	—	+	—
Alcohol mgm. in 5 ml. of medium	30.1	19.0	33.9	33.4	35.4	32.8	23.6	23.6	23.8	27.3
Percentage of sucrose consumed	78.1	54.1	86.2	84.3	78.4	74.3	48.1	48.5	51.1	59.5
Growth	+	++	+	+	+	+	+	+	+	+
	+ With the vitamin.					— Without the vitamin.				

Biotin, pyridoxine, calcium pantothenate, thiamin and inositol represented the B-vitamins found essential for this strain of yeast during an 18-hour growth period.

The experimental medium used for the study of alcohol production was composed of a mixture of (1) 25 c.c. of a 20 per cent. solution of sucrose, (2) 5 c.c. of a 15 per cent. solution of ammonium sulphate, (3) 25 c.c. of salt solution (containing KH_2PO_4 and salts of Mg, Ca, Mn, Fe, Sn, B, Zn and Cu), and (4) 10 c.c. of McIlvaine's citric acid disodium hydrogen phosphate buffer of pH. 4.5., made up to 100 c.c.

The inoculum was prepared by growing the yeast in (1) an "all vitamins" medium of glucose, salts, $(\text{NH}_4)_2\text{SO}_4$, *l*-aspartic acid, and containing the following vitamins; thiamin, pyridoxine, riboflavin, calcium pantothenate, biotin, inositol, nicotinic acid and *p*-aminobenzoic acid and (2) in a similar medium from which one of the vitamins at a time was omitted. After incubation for 96 hours at 28° C., the yeast was cen-

not influence alcohol production; this is not surprising in view of the fact that our nutritional studies have revealed that this yeast is capable of synthesizing its own requirements of thiamin, given a sufficient period of time. In the case of the biotin-fed inoculum, there is a substantial multiplication of the yeast cells during fermentation (see Table). It would appear, therefore, advisable to fortify the medium with biotin-containing supplements during the preparation of "pitch" in distillery practice.

(Miss) VIOLET DE SOUZA.

M. SR. ENIVASAYA.

Section of Fermentation Technology,
Indian Institute of Science,
Bangalore, 15th November 1945.

¹ R. J. Williams, W. A. Mosher and E. R. Rohrmann, *Biochem. J.*, 1936, **30**, 2036. ² E. F. Pratt and R. J. Williams, *J. Gen. Physiol.*, 1939, **22**, 637. ³ R. H. Winkler, D. Burk, V. Du Vigneaud, *Arch. Biochem.*, 1944, **5**, 25. ⁴ M. J. Johnson, *Ind. Eng. Chem., Anal. Ed.*, 1932, **4**, 20. ⁵ H. R. Stiles, W. H. Peterson and E. B. Fred, *J. Bact.*, 1926, **12**, 427.



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BASIC REQUIREMENTS OF INDUSTRY

THE problems connected with the planned industrial development of India for ensuring the maximum utilization of the resources, for providing a stable and high level of employment and raising the standard of living of the people, are receiving the serious attention of the Government and the people alike. The Government have announced their policy of actively assisting industrialization and have set up a number of panels to examine the details relating to various industries and make recommendations to enable the Government to draw up a plan for five years as the first stage of a 15-Year Plan.

In the ultimate analysis, industrial production depends upon the provision of plant and machinery; scientific instruments are also important as they constitute the fundamental tools of technical research and development, essential for progressive industrial activity. These basic requirements must be satisfied if industrialization is to be real and enduring.

In the industrial development of India two phases of development can be distinguished. In the first, consumer goods are produced with the aid of imported plant and machinery and of foreign technical experts. In the second phase, capital goods are produced in the country itself, enabling the manufacture of articles required for the home market. The country is still largely in the first stage of development, and Indian industrialists are exploring foreign markets for capital equipment and are endeavouring to obtain the services of foreign technical

experts. These explorations have revealed that there is little likelihood of securing the requirements in the near future, although there is considerable sympathy and goodwill for Indian aspirations in the United Kingdom, United States of America and Canada.

India Forty Years Behind Britain

The position in India to-day is very much the same as it was in Britain forty years ago, at the commencement of World War I. Referring to the position of the chemical industry in Britain at that time, *Chemical Age** points out:

"We had been slow to accept the responsibility of providing plant and research for the manufacture of many things that were vital to the waging of war. We had been offered them by Germany and we had accepted the legend of heaven-born scientific inspiration of the German chemists and industrialists. Consequently we found ourselves in Queer Street in regard to scientific glassware and fine chemicals—to mention only two items. Accordingly, when the war had shut off our supplies, we went back as we should have done years before. We trusted our technical men and gave them their head. Later, we assisted their efforts by a protective tariff.

"The result is that to-day this country has nothing to fear from any nation in the world in these two fields of technical manufacture. The second German war has shown once again that British scientists and engineers are fully equal to those of any other nation and has finally dispelled the claim that supreme skill in any technical field is the sole prerogative of any one nation. All that is required is practice—the opportunity to gain experience, to put theory into terms of iron and steel, of non-ferrous metals, of stone or glass. We repeat all that is needed is the opportunity to acquire skill through experience."

* 1945, 52, 25.

"Casting the mind back through forty years, we remember how the Briton would invent, the German would develop. The British manufacturer of consumer goods set his face against trying out anything new until someone else had got it over its teething troubles. His creed was very simple—and highly specious. 'Why,' he said, 'should I spend my money in trying out new things and often burning my fingers when these foolish Germans will do it for me? I save my money and get from them a finished article which will work often cheaper than I could buy it here.' This sounded very hard-headed and business-like, but it neglected one fact. The Germans through their system of trial and error, were steadily building up a fund of experience and technical background which then, and even more so later, they were able to put to good use. Ultimately, in the eyes of the world, they became the nation that did things; we were the copyists. We recollect, for example, how no one would think of designing a coke oven unless they had either a German firm who sent the designs or else German designers trained in Germany working in the British offices. In practice, the Germans made just as many mistakes as we did, or as anyone else would have done; but they had put themselves in a position to profit by their mistakes: we had not."

In the years between the two World Wars Britain with an Empire market at her command, developed her engineering industry and attained a high position as an exporter of producer goods. India, unfortunately, did not take advantage of the opportunities provided by the two World Wars, and she continues to be where she was years ago, dependent on other countries for her basic requirements. During the war years, the productive capacity of her industries was put to excessive strain and her industrial plant and machinery have been worked to "rack and ruin." They need to be replaced. Additional equipment is needed to implement her plans of industrialization. At a very conservative estimate, the equipment required is valued at 80-100 million dollars per year for the next five years. The gigantic demands on the United Kingdom, and the United States of America from all over the world for capital and consumer goods are such that India cannot hope to get her requirements from either of these countries for at least two years to come. The lesson is clear. India can profit from the experience of Britain, and under the stress of necessity, Indian engineers and industrialists should make a supreme effort to make India self-sufficient with respect to her basic requirements.

Equipment can be made in India

Reviewing the present position, Sir M. Visvesvaraya stated in his Presidential

Address to the All-India Manufacturers' Organization (16th September, 1945).

"The proper thing to do, if capital goods cannot be obtained in the near future from Europe and America, is to begin to manufacture heavy machinery and machine tools on a large scale, in one or two business centres, within the country itself. I have visited factories and workshops in several parts of India in which small size intricate machinery and machine tools and parts are being produced to replace articles which were supplied by foreign imports before the war. Such parts are being made not only for local consumption but are being supplied to distant places within the country.

"I have also some knowledge of machine manufacturing industries in cities like Detroit and Berlin. The manufacture of large size machinery is not attempted in India, not because people are unwilling to take risks, not because of lack of capable men to quickly learn the operations, but because of the fear that after the war, the products may not be protected from foreign competition.

"We have been importing capital goods for over 50 years. If this country does not even now attempt to build machinery or machine tools for itself as the United States of America and Russia have done in the past with the co-operation of their Governments, we may go on importing capital goods for all time."

A beginning has indeed been made during the war years. In the field of chemical industry, for instance, complete distillery units and plants for the hydrogenation of oils have been fabricated in India. Under admittedly difficult conditions, Indian engineers and technicians have shown sufficient inventiveness and resourcefulness to justify the establishment of a large-scale plant manufacturing and chemical engineering industry in the country. All that is needed is opportunity to learn, and encouragement to go forward.

The Scientific Instruments Industry

Regarding the manufacture of scientific instruments and equipment also, the position in India is much the same as it was in Britain before the first Great War. When the war broke out and foreign supplies were cut off, British instruments manufacturers were called upon to produce all the instruments required which they did successfully. Their position improved in the years that followed, and in 1939, there were no less than 18,000 operatives engaged in that industry handling business valued at £7,500,000 of which £2,000,000 represented export trade. By 1943-44, the number of operatives had increased to 50,000 and the total value of manufactured instruments and

equipment reached £50,000,000. Britain has, to-day, a greatly enlarged industry equipped with specialized machinery and an army of trained personnel.

Every progressive country has a highly developed and well organized scientific instruments industry, rightly called the "master key industry," as it produces the tools with which the scientists work. It is as essential for peace-time developments as for waging of wars. History records that during the Franco-Prussian War, Bismark realizing the basic importance of scientific instruments, particularly optical instruments, took the initiative for organizing the industry in Germany. The firms of Zeiss, Abbe and Schott were merged, and through State control and encouragement a large industry was built up, which later attained a high state of efficiency and virtually held a world monopoly for optical instruments.

In an editorial* which appeared in this *Journal*, the position of the scientific instruments industry in India was reviewed and a strong plea was made for strengthening it through the establishment of a Scientific Instruments Manufacturers' Research Association. The industry cannot thrive without the help of competent design and research staff, and in view of its national importance, State encouragement is essential to its progress and prosperity. The need for

* 1944, 2, 75.

developing the industry has been stressed by Prof. A. V. Hill in his *Report on Scientific Research in India*. It is stated that given training and experience, Indian workmen have all the natural aptitudes for the manufacture of scientific instruments and apparatus.

It will be clear from this brief survey, that India is sadly lacking in some of the basic requirements which are essential for productive activity. That manufacture of capital goods and scientific instruments is entitled to a high priority in any plan of national development will be conceded by every one. All the assistance needed for the development of these industries should be provided forthwith. Facilities for teaching and research in engineering should be considerably enlarged, and State aid and encouragement should be given in a generous measure. The Department of Planning and Development of the Government of India has set up panels composed of leaders of science and industry to prepare plans for these industries. Mr. Coes of *Messrs. Ford, Bacon and Davis, Inc.*, U.S.A., is now in India at the invitation of the Government to advise the latter on the development of engineering industries. These measures are reassuring. The end of war has not only brought great problems but also great opportunities and the economic prosperity of the country will be largely determined by the wisdom with which these opportunities are utilized.

THE CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE

THE foundation-stone of the *Central Glass and Ceramic Research Institute*, the first of the five National Laboratories which the *Council of Scientific and Industrial Research* is to establish in India, was laid on Monday, 24th December 1945, by the Hon'ble Sir Ardeshir Dalal, K.C.I.E., Member in charge of the Department of Planning and Development, at Jadavpur, Calcutta, in the presence of a large and distinguished gathering of scientists, representatives of the glass and ceramic industries, and public men.

In his address of welcome, Sir Shanti

Swarup Bhatnagar, Director of Scientific and Industrial Research, and Chairman of the *Institute Committee*, said that the present scheme for the *Glass and Ceramic Research Institute* was expected to cost a total of 12 lakhs of rupees. The original figure of a crore of rupees for the proposed five national laboratories and two research stations for building and road research, was now approaching more nearly one and a half crores as the detailed estimates of the laboratories were being worked out. It was a matter of considerable satisfaction to note that industry itself had come out with

generous donations to meet a part of the demand. However, judged in the light of what other countries had spent, and were planning to spend, on scientific and industrial research, one or two crores appeared like a drop in the ocean.

Sir Ardeshir Dalal dwelt upon the great importance of science to industry and referred to the projected chain of five national laboratories which would provide a network of scientific institutions for helping the industrial development of India. "It was the second World War, which has just ended," he said, "that demonstrated in an unmistakable fashion the vital necessity of scientific research not only in the field of industry but in almost every field of material advance, so that research has now come to occupy a most important place in the activities of the advanced States. It was scientific research which contributed perhaps more than anything else to the winning of the last war and certainly curtailed its duration." Referring to the glass industry, Sir Ardeshir said: "Although favourably situated in the matter of the availability of raw materials, markets and labour, the Indian glass industry had always suffered from lack of competent technological advice and guidance. It was to satisfy this long-felt need that the *Institute* was being established and he hoped that its services would be fully and freely made use of by the industry throughout the country. The necessity for the most cordial co-operation between the industry and this *Institute* could not be overemphasized and so far as

it lay in their power, the management of the *Institute* would be prepared to render the utmost help to the glass as well as the ceramic industry."

Dr. Atma Ram, Officer-in-charge of the *Institute*, thanked Sir Ardeshir Dalal and the guests. At his request, Mr. J. K. Gora of *Messrs. Ballardie Thompson and Mathews*, official architects to the *Institute*, escorted the Hon'ble Sir Ardeshir Dalal to the site of the foundation-stone. A beautiful silver trowel bearing the crest of the Council, and a hammer made in enamel (made by *Messrs. Sur Enamel and Stamping Works, Calcutta*), were presented to the Hon'ble Member on behalf of the *Institute*. With the help of these implements, Sir Ardeshir laid the mortar on the foundation in the conventional manner and declared the stone well and truly laid.

Speaking at a luncheon given in his honour by Mr. D. N. Sen, President of the *Bengal Glass Manufacturers' Association*, Sir Ardeshir Dalal said that he was glad to find that Indian industrialists had now become conscious of the necessity of increasing their efficiency in order to meet overseas competition successfully. Hitherto the general practice was to claim tariff protection alone. Tariff protection had no doubt a place in developing indigenous industries, but, he added, at the same time technical efficiency of the industries had also to be improved if India was to take a forward stride towards industrialization.

'CURRENT SCIENCE'—A FORTNIGHTLY

At the special General Body meeting of the *Current Science Association* held at Bangalore during the Science Congress week (4th January 1946) it was resolved that immediate steps be taken to publish the journal as a fortnightly.

The Working Committee had suggested that: (1) the journal may be published as a fortnightly without materially increasing the number of pages and without increasing the rates of subscription; and (2) with a view to accommodate the increasing amount of scientific matter, the Editor should seek the co-operation of contributors in securing greater brevity of expression and presentation. These suggestions received the enthusiastic and wholehearted support of the members of the Association.

Current Science was founded as a monthly in 1932, and was being issued during the first decade of

its progress under the authority of an Editorial Board. In August 1942, the journal was invested with a constitution and the *Current Science Association*, a registered body, is now the legal custodian of the journal.

The decision of the Association to issue the journal as a fortnightly will be welcomed by scientists all over the country. This development follows logically from the progressive policy pursued by the authorities of the journal, and meets the requirements of the rapidly expanding scientific activities in India. It will enable the Indian scientists to bring promptly to the notice of their confreres all over the world, the results of their devoted endeavours to advance the bounds of scientific knowledge. The journal which enjoys a wide reputation enters its "fortnightly" career with added vigour and prestige. We heartily welcome this development.

Review of Some Recent Developments in Applied Science

SYNTHETIC DYES

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RESearch on the chemistry and technology of dyes has been affected unfavourably by the war. The literature of dyestuff chemistry consists largely of patents and the research laboratories of the great dyestuff firms have usually been responsible for the bulk of the work in this field. During the war the dyestuff firms have been pre-occupied with the demand for vastly increased quantities of a few dyes—khaki, olives and blues, and otherwise with the utilization of their plant and resources for the production of materials required for the immediate purposes of the war. It is, therefore, natural that there should be a progressive reduction in the number of patents on intermediates and dyes since 1940 in comparison with the pre-war years. It is likely that important advances have been made in methods of production and plant design with reference to the limited range of war-time dyes and the intermediates required for these dyes and for the manufacture of pharmaceutical and other products, such as the sulpho drugs, rubber chemicals and explosives. These developments would doubtless be of general value for the dyestuff industry when it resumes its normal plans of production. It must be noted, however, that the reconversion of the dyestuff industry will involve much more serious problems than in the case of many of the other chemical industries. The manufacturers of alkalis, acids, solvents, etc., may need to overhaul, renovate and modernize their plant, but they will continue to produce the same chemicals; the dye industry will have to change from a few dyes turned out on a large scale to hundreds and thousands of dyes, if possible with improved brilliance and fastness. Soldiers, nurses and others returning from the war, as well as the civilians who have had to be content with whatever cloth may be available, are bound to seek relief from the drab colours which are inevitably associated with war; the dye manufacturer will thus

face a demand in the post-war years for bright, beautiful and varied colours. A tremendous increase in the *tempo* of research in tinctorial chemistry may be anticipated, but perhaps not for some time, since the first concern of the dyestuff firms will be to reconvert their organization to normal production and to fill the gap in the world supply of dyes created by the dismemberment and incapacitation of the *I. G. Farbenindustrie*.

An annual survey of the published work on intermediates and colouring matters is made in the *Reports of the Progress of Applied Chemistry* issued by the Society of Chemical Industry. The object of this brief note, which it is hoped will be an annual feature of the *Journal*, will be to indicate the main lines of advance in dyestuff chemistry during the period under review, and to give an account of any developments in the chemistry and technology of dyes that may have taken place in India.

Azo Dyes

Direct cotton dyes, which are prepared from the usual types of symmetrical diamines or other components known to yield substantive dyes, and which are characterized by their suitability for aftertreatment with formaldehyde, have been covered by *E. I. Du Pont de Nemours & Co.* in a series of patents¹. Patents also continue to be taken on substantive dyes, which may be after-treated by other methods, e.g., on dyes containing free amino groups which may be diazotized on the fibre and coupled with *m*-phenylene diamine or β -naphthol,² and on dyes which may be developed with diazo salts³. The practical exploitation of such patents is limited by the fact that the advantage of direct dyes is their ready applicability by a single process, and this will be removed by additional processes of aftertreatment, unless the expenditure of time, labour and material are much more than compensated by the improvement in the fastness properties that is actually obtainable.

Aminoguanidine has been diazotized and coupled with naphthols⁴. The dyes are very soluble in alkali, but fast shades are stated to be obtained on wool.

2:4-Diarylpyrroles couple with diazotized arylamines to give both acid dyes for wool and direct cotton dyes⁵.

The metal complexes of mordant azo dyes continue to receive attention in view of their importance in the dyeing of wool and silk. Many new combinations have been mentioned in recent patent literature for the preparation of metallisable disazo- and polyazo-dyes⁶. It has been shown by Fierz-David and his collaborators (1937) that some of the direct cotton dyes which possess outstanding fastness to light are similarly constituted; and Rowe (1938) has mentioned that copper co-ordination complexes of *o*:*o*'-dihydroxy- or *o*-hydroxy-*o*'-carboxy-azo dyes are included in the Sirius and Sirius Supra series (*I. G.*) and the Durazol (*I. C. I.*) series of light fast direct dyes⁷. Among the commercial range of direct cotton colours, which have survived the competition of the fast dyes of the vat and azoic classes, the fast-to-light dyes are important, and metallised azo dyes suitable for application to cotton and rayon will be the subject of extensive investigation. Patents of the *Ciba Co.* on direct dyes are specially concerned with the union of azoic components by a 1:3:5-triazine ring, using cyanuric chloride for the condensation; the dyes may be converted in substance into metal complexes, or the dyeings may be rendered faster by after-coppering⁸.

Although the constitution of the lakes of many dyes has been elucidated, notably by Morgan⁹ and Drew¹⁰, and structural formulae have been suggested for a few of the Neolan and Palatine Fast colours, the specific properties of the water-soluble complexes and the mechanism of their fixation on the protein fibres must be further investigated.

The possibilities for azoic combinations being unlimited, patents still appear on the preparation of new "naphthols" and bases in spite of the plethora of patents on the subject during the quarter century preceding the war. For the acid half of the "naphthols," the replacement of hydroxynaphthoic acid by numerous other *o*-hydroxycarboxylic acids, particularly heterocyclic compounds, has been suggested. In view of the limited series of yellow-producing "naphthols" commercially available, attempts are being made to extend the range and to arrive at β -ketocarboxylic acid arylides with improved properties.

Examples are the acetoacetamides of aminodibenzfurans¹¹; the arylamides of indolyl-acetic esters¹²; and the arylamides of acylacetic esters in which the acyl is an aryl or arylene-*bis*-acrylic acid radical (e.g., cinnamoyl)¹³.

The constitution of several of the commercial "naphthols" has been determined by Desai and Mehta¹⁴. Naphtol AS-S, marketed by the *I. G.* in 1938 as a highly substantive "naphthol" for red combinations, has been shown to be the condensation product of hydroxynaphthoic acid and 2-amino-3-methoxydibenzofuran¹⁵. While the Brenthols are the *I. C. I.* analogues of the Naphtol AS series, a Brenthol which does not correspond to any of the Naphtols is Brenthol BA, which is the 5-bromo-2-methoxyanilide of hydroxynaphthoic acid¹⁵.

Among the primary amines more recently suggested for use as "bases" in azoic dyeing are a series of sulphones¹⁶; tetraminophthalocyanines¹⁷, leading to green and greenish-blue shades of good fastness; and diaminodiphenyldisulphides¹⁸.

The aminoanthraquinones are useful bases, but while the stabilized diazo salt from α -aminoanthraquinone has been marketed, the use of the amines themselves has been limited by the difficulty in diazotizing them. A simple procedure has now been evolved for diazotizing the aminoanthraquinones by means of concentrated hydrochloric acid and solid sodium nitrite¹⁹.

A novel combination of the constituents of an azoic dye and a solubilized vat colour is involved in the preparation of the leuco-hydrogen sulphates (sodium salts) of the azoic dye from diazotized 1-aminoanthraquinone and acetoacet-*m*-trifluoromethyl-anilide; oxidation on the fibre leads to fast yellow to brown dyeings²⁰.

Certain other aspects of azoic dyes have been surveyed recently²¹.

Anthraquinonoid Vat Dyes

Representing the fastest group of dyes available for cotton, the vat dyes derived from anthraquinone have been extensively investigated, but progress has been more in the direction of improved methods of preparation of known intermediates and dyes, and of modifications in the constitution of the established classes of dyes, rather than in the discovery of new types. Thus the halogenated aminoanthraquinones and the halogenated indanthrones have been the subject of recent

patents. While Gubelmann, Weiland and Stallmann²² have stated that 1-amino-2:4-dichloroanthraquinone cannot be prepared by direct chlorination of α -aminoanthraquinone, this is practicable under suitable conditions²³, and the intermediate is of wide utility in the preparation of vat and acid colours. Fast grey vat dyes are obtainable by fusing benzanthrone with caustic soda and subsequent treatment with sulphuric acid²⁴. Numerous British and American patents cover developments in other series of anthraquinonoid vat dyes, of which there are already commercial representatives, such as the acylamidoanthraquinones, anthrapyridones and analogous types, anthrimides, dibenzanthrones and *isodibenzanthrones*, and phthaloylcarbazoles. The acylamidoanthraquinone series is extended by the use of acids, such as 2-chloroanthraquinone-6-carboxylic acid, derived from anthraquinone²⁵. Aminoanthraquinones are condensed with the chlorides of amino-carboxyanilino-anthrapyridones²⁶. 1-Benzamido-4-carboxyanilino anthraquinones are condensed with vatable primary aminoanthraquinones²⁷. A vat dye of interest in war-time is *Caledon Khaki 2G* (Indanthrene Khaki GG), which is a complex tetracarbazole. The anthraquinone-carbazoles as a class have excellent fastness. In a recent patent, very fast, brown vat dyes of this type are claimed by the aluminium chloride cyclisation of benzacridonoyl-trianthrimides²⁸. "Trianthrimide-carbazoles" are prepared by interaction of 1:6-dichloroanthraquinone with an aminoanthraquinone, followed by cyclization²⁹. Orange to red vat dyes of good fastness to light and chlorine are obtained by condensing 5-amino-2:1-anthraquinone-thioxanthone with 1-chloro-4-or-8-benzamidoanthraquinone, and cyclizing to the carbazole, followed by oxidation³⁰.

One line of advance is the preparation of complex dyes which represent a combination of two or more nuclei, each of which was utilized individually in the older dyes. A monaminopyranthrone may be condensed with a dibromodibenzanthrone to yield olive to greenish-black dyes³¹. New anthraquinonoid dyestuffs are obtained by reacting anthraquinone-acridones with anthraquinone-carbazoles³².

A departure from the usual methods of preparing solubilized vat colours is the treatment of the aqueous vat with a halide or anhydride of a polybasic organic sul-

phonic, carboxylic or sulpho-carboxylic acid in presence of a polyethylene glycol or the product of the condensation of a high molecular weight alcohol with ethylene oxide³³.

The patents deal with the chemistry of the reactions and the constitution of the dyes to some extent, but there is much scope for investigation, since adequate experimental evidence is lacking even in the case of many dyes which are used commercially and for which the constitution has been recorded in standard publications.

Bradley and Derrett-Smith have examined the behaviour of dyeings of all available British, German and Swiss vat dyes in four chemical tests with the object of compiling tables of characteristics by means of which a vat dye may be readily identified on linen and cotton materials³⁴.

Indanthrene Olive Green B has been shown by Maki and Kikuchi to be a "benzanthrone-acridone" obtained by the cyclization of 3-benzanthronyl-1-anthraquinonylamine³⁵.

Acid Colours

Acid and acid mordant colours derived from anthraquinone have been known for a long time, and many dyes of this type are in common use for wool and silk. While the main commercial representatives are sulphonic acids of arylaminoanthraquinones, which may in addition contain hydroxyl, amino and other groups, the patent literature gives evidence of sustained attempts to improve methods of preparation and to prepare new members of the series. Thus grey dyes for wool are prepared by sulphonating the condensation products of 1-amino-4-arylaminoanthraquinones with 3:9-dihalogenobenzanthrones³⁶. Sulphonated 4-arylamino-1-dimethyl-aminoanthraquinones, are green-blue acid wool dyes of greener shade than the corresponding monoalkylamino compounds³⁷.

Brown acid wool dyes, probably sulphonated carbazoles, are obtained by treating a 1-*p*-benzeneazoanilinoanthraquinone with fuming sulphuric acid³⁸.

Wool dyes, related to vat dyes for cotton of the type of Indanthrene Dark Blue BO (dibenzanthrone) and Caledon Jade Green, are prepared by sulphating the *bishydroxy*-alkyl ethers of 16:17-dihydroxydibenzanthrone³⁹.

Sulphur Dyes

Nitrophenols, aminophenols and indophenols continue to be the types of intermediates which are employed for thionation. In a recent patent granted to *General Aniline and Film Corporation*, brown, olive and grey dyes are obtained by sulphurizing coeramidones and dicoeramidones⁴⁰.

The chemistry of sulphur dyes remains in an unsatisfactory state, and little progress has been recorded after the investigations of Fierz-David⁴¹; the present position has been reviewed by Jones⁴².

Phthalocyanines

Since the discovery of the phthalocyanines by *Scottish Dyes* in 1928, and the elucidation of their structure and mode of formation by Linstead (1934), they have been widely investigated and many patents have been taken on improved methods of preparation of phthalodinitrile and of the pigments, on the introduction of other metals in place of copper, on the halogenation of the phthalocyanines, etc. While the use of the phthalocyanines is still largely as pigments in printing inks, paints and lacquers, their application to textiles is being increasingly examined. One obvious development is the use of the phthalocyanines in the pigment printing process for textiles mentioned earlier. By the sulphonation of the phthalocyanines direct and acid colours are obtainable, and by the introduction of suitable groups attempts are being made to make the phthalocyanines available for dyeing and printing textiles by recognized methods. Sulphur dyes for cotton are made by heating a phthalocyanine sulphonyl chloride with a thiol⁴³.

Cellulose Acetate Dyes

In the early days of the manufacture of acetate silk, there was a lack of suitable dyes for this cellulose ester, but now numerous dyes for acetate silk are available, based on the fact that cellulose acetate behaves like an organic solvent, and readily takes up a variety of dyes offered as colloidal dispersions in water. The two main types are azo dyes and comparatively simple derivatives of anthraquinone, such as the amino- and amino-hydroxyanthraquinones. The *Eastman Kodak Co.* has been particularly active in this field in recent years⁴⁴.

Pigment Printing

Pigment processes of calico printing, comprising the use of pastes containing a synthetic resin, water-insoluble dyes and an organic solvent, are coming into vogue. The "Aridyes" (*Inter-chemical Corporation*) were the first printing pastes of the type to be marketed, and the patent literature gives evidence of a race among dye manufacturers for the production of similar pigment emulsions. Patni⁴⁵ has examined a series of Aridyes, which are three-phase emulsions with an outer, continuous, water-immiscible lacquer phase thickened by an inner aqueous phase, the binding resin being incorporated as a solution in a suitable solvent. The resin is generally a glyptal, and the colouring matters are of the anthraquinonoid vat, azoic and phthalocyanine class. After printing and drying the fabric at 120°-150° for a few minutes, the binding action of the resin is adequate for good fastness to washing, but the fastness of the prints to rubbing is only moderate. If the limitations of the present range of pigment emulsions can be removed, the method will undoubtedly prove to be a useful development in calico printing. Printing emulsions have been prepared from modified cashew-nut shell oil as a binding medium for vat and azoic dyes⁴⁵; they have a water-miscible continuous phase, and dilution may be effected by using sulphonated oils and gelatine in water. The colour of the resins restricts the range of dyes that may be employed. Ethyl cellulose in amyl acetate and similar solvents has also proved to be of value for the preparation of pigment printing emulsions.

The advantages and disadvantages of pigment printing have been critically examined in recent papers^{46, 47}. In a symposium on the application of pigments to textiles, the types of pigments at present available, and some of the physical and chemical properties which affect their application, have been discussed⁴⁷. Describing the use of resins, especially urea and melamine-formaldehyde resins, in the fixation of pigments, it is shown that the resins are applied as precondensates at the methylol stage. The dimethyl ether of dimethylolurea and hexamethylolmelamine are preferred, since they can be manufactured in a state of high purity. Among the other problems receiving consideration are the insolubility of modern fixing agents, the toxic and fire hazards of

solvents, and the fastness of the prints to wet rubbing.

Infra-red radiation may be used for curing the pigmented resins⁴⁸.

"Orema" dyes, described as a "new class of dyes for textile printing," are very finely divided pigments made into stable pastes, which give clear bright prints by fixation at 100-120°. If carrageen moss is added, slop padding methods may be used⁴⁹.

Colour, Constitution and Affinity of Dyes for Textile Fibres

Considerable success has been achieved in recent years in placing the relationship between colour and chemical constitution on a quantitative basis⁵⁰. Pauling's concept of resonance between valency structures has helped in the elucidation of many problems of molecular structure, and attempts have been made to calculate the absorption spectra of several organic compounds with conjugated systems. Lewis and Calvin in a discussion on resonance in relation to colour have postulated that the type of resonance contributing to the absorption of light is exclusively that which results in the oscillation of a "formal" electrical charge.

Certain qualitative correlations between the chemical constitution of dyes and their affinity (or "substantivity") for cellulose have been discussed recently²¹. Among similar groups of dyes, the substantivity increases from the benzene to the naphthalene, anthracene and the more complex, condensed polynuclear aromatic hydrocarbon series. This is not due to the mere increase in molecular weight, but the special characteristics of the valence bond structures are involved. The leuco compounds of the anthraquinonoid vat colours as a class are characterized by high substantivity. The leuco compounds, for instance, of dibenzanthrone (Indanthrene Dark Blue BO), its 16:17-dimethoxy derivative (Caledon Jade Green) and isodibenzanthrone (Indanthrene Brilliant Violet R) are very highly substantive; and the complete absence of nitrogen and sulphur, invariable constituents of the direct cotton colours, will be noticed. The alkaline solutions of the reduction products (or "vats") of some of the anthraquinone vat dyes have such high affinity for cotton, and the baths are so rapidly exhausted, that the dyeing process has to be retarded and controlled by the addition of restraining and

level dyeing agents, consisting of glue or synthetic protective colloids.

The substantivity of the anthraquinonoid vats is associated with the resonance among numerous valence-bond structures by which the higher condensed ring systems can be represented. The angular ring systems have a larger number of stable resonating structures and a larger resonance energy than the corresponding linear ring systems. Angular configuration of condensed ring systems is a common feature of anthraquinone vat dyes. Among the isomeric dihydro-anthraquinone-azines, the commercial product which possesses the substantivity necessary for practical dyeing is indanthrone (Indanthrene Blue RSN), having the *bis*-angular orientation, and the tetracarbazole, Indanthrene Khaki GG. The more complex the polynuclear system and the greater the number of benzene rings, the larger will be the resonance energy. One effect of resonance will be co-planar configuration of the molecules. It would appear that there is a broad correlation between the number of stable resonance forms and the resonance energy on the one hand, and the substantivity on the other, of the leuco compounds of anthraquinone vat dyes.

The older conceptions of substantive dyes as those possessing long thread-like molecules of approximately straight line form, which were based on the benzidine type of azo dyes, must be modified in view of the constitution of the highly substantive leuco compounds of the anthraquinone vat dyes. The affinity of a complex polynuclear dye such as Indanthrene Khaki GG probably involves the attachment of the dye molecules to several parallel cellulose units at suitable points, so that the dye molecules act as bridges or grids in a three-dimensional network.

While the indigoid and thioindigoid vats are yellow, the anthraquinone vat dyes give intensely coloured vats; Indanthrene Yellow G thus gives a deep blue vat. Alkaline reduction of an anthraquinone vat dye produces auxochromic hydroxyl groups which introduce much greater possibilities of resonance than in the case of the leuco-indigoids, on account of the large number of aromatic ring systems. Bathochromic effect and substantivity do not always go together, but there seems to be enough evidence to believe that the resonance factors favourable for intense colour are also favourable for

substantivity in the anthraquinone vats, the requirements regarding the degree of dispersity in aqueous solution being satisfied.

The conversion of the leuco-forms of vat dyes to the sulphuric esters, the sodium salts of which are marketed as Indigosols and Soledons, greatly reduces the substantivity. The reduction in substantivity may be correlated with the change in the colloidal and electrochemical character of the solution, as well as the restraining influence of the sulphonic group on the resonance of the molecule. Among the Indigosols and Soledons, the anthraquinone derivatives have in general higher substantivity than the indigo and thioindigo derivatives, and in the former group the substantivities run roughly parallel with those of the vats of the parent dyes.

Research with Reference to an Indian Dyestuff Industry

It is only in recent years that the importance of the dyestuff industry to the economy of the country has been realized in India, although textiles constitute our premier industry and our annual import of dyes has been of the value of about four crores of rupees. The history of the dyestuff industry in other parts of the world, particularly in Great Britain, its intimate relation to other chemical industries, and the experience of the two great wars are a clear demonstration of the need for organizing the indigenous production of coal-tar intermediates, dyes and synthetic organic chemicals. In 1941 the Government of India, on the recommendation of the Board of Scientific and Industrial Research, appointed an Exploratory Committee to consider ways and means for the manufacture of synthetic dyes. The terms of reference were (1) to make a rough survey of the consumption of the various kinds of dyes in India; (2) to survey the raw materials and heavy chemicals available for the manufacture of dyestuffs in India; and (3) to consider the practicability, both technical and economic, for the manufacture of such dyes in India as are capable of production within a period of 15 years.

While the range of dyes employed by our mills and for other purposes runs into hundreds, about 50 per cent. of our dye consumption would be represented by a comparatively narrow range of 50 dyes. At the instance of the Dyes Committee the necessary raw materials for these 50 dyes,

which could be regarded as the basis of a 15-year plan for the establishment of a dye industry, have been examined, and data collected on their production in India. The survey⁵¹ disclosed that the raw material position was on the whole favourable, and further discussion with experts led to the conclusion that, provided certain conditions could be fulfilled, it was practicable to manufacture all the dyes in substantial demand in the country within a period of 15 to 20 years.

Research on synthetic dyes should have ample provision in the national programme of research. The pre-war leadership of Germany in the manufacture of dyes and medicinal chemicals was mainly due to her far-sighted encouragement of research. Great Britain and America were not long in learning this lesson, and it has been computed that the American dye manufacturer spends over two million dollars per year on research, devoted not so much to the discovery of new dyes, which must necessarily become less frequent with the passing of time, but to continuous improvement in methods of production and plant design. The expenditure of the *Imperial Chemical Industries* in 1943 on research and development was over Rs. 3,00,00,000, and this figure was exceeded in 1944.

The *Council of Scientific and Industrial Research*, through its Synthetic Dyestuffs Committee, is sponsoring schemes of research on coal-tar intermediates and dyes, and the results of the investigations appear in this *Journal* or elsewhere from time to time. Among the problems which are receiving attention, a general scheme of work on the constitution and composition of commercial dyes marketed in India has been included. The survey of raw materials for an Indian dyestuff industry⁵¹ carried out on behalf of the *Council* indicated the absence of adequate information on the amount of parent dye or the percentage of the essential tinctorial constituents in the dyes marketed in this country, the nature and quantity of the diluents used for purposes of "standardization," and in some cases the chemical constitution of the dyes. Apart from the obvious need for such data in connection with the project for establishing the manufacture of intermediates and dyes, the wider objects are to enlarge our knowledge of the chemistry of synthetic dyes and to develop a school of research in this important field.

References

- 1 U.S.P., 2, 228, 415; 2, 249, 045; 2, 249, 334; 2, 234, 201; 2, 263, 894; 2, 322, 750; 2, 322, 746.
- 2 U.S.P., 2, 138, 991.
- 3 B.P., 564, 024; 564, 258.
- 4 Shreve, Carter and Willis, *Ind. Eng. Chem.*, 1944, **36**, 426.
- 5 B.P., 562, 762.
- 6 B.P., 541, 692; 544, 673; U.S.P., 2, 136, 650.
- 7 "The development of the Chemistry of Commercial Synthetic Dyes," *Institute of Chemistry Lectures*.
- 8 B.P., 541, 968.
- 9 Morgan, *et al.*, *J. Chem. Soc.*, 1915, **107**, 645, *et sequa*.
- 10 Drew *et al.*, *Ibid.*, 1940, 1062, and previous papers.
- 11 B.P., 540, 743.
- 12 B.P., 512, 799.
- 13 B.P., 512, 845.
- 14 *J. Soc. Dyers Col.*, 1938, **54**, 422.
- 15 Moualim and Venkataraman, *J. Sci. Ind. Res.*, 1945, **3**, 447.
- 16 B.P., 546, 301; 546, 428; 546, 277-81.
- 17 B.P., 535, 935.
- 18 B.P., 559, 784.
- 19 Moualim and Venkataraman, *Indian Patent Application*.
- 20 U.S.P., 2, 316, 758.
- 21 Venkataraman, *Presidential address, Section of Chemistry, Indian Science Congress*, 1945.
- 22 *Ind. Eng. Chem.*, 1929, **21**, 1231.
- 23 Bedekar and Venkataraman, *Indian Patent Application*.
- 24 Gokhale and Venkataraman, *Indian Patent No.* 31594.
- 25 U.S.P., 2, 181, 048.
- 26 B.P., 560, 131.
- 27 B.P., 561, 420.
- 28 U.S.P., 2, 315, 537.
- 29 B.P., 542, 594.
- 30 B.P., 561, 754.
- 31 U.S.P., 2, 300, 832.
- 32 *Indian Patent*, 31184.
- 33 U.S.P., 2, 307, 893.
- 34 *J. Soc. Dyers Col.*, 1940, **56**, 97.
- 35 *J. Soc. Chem. Ind. Japan*, 1939, **42**, 316B.
- 36 U.S.P., 2, 293, 709.
- 37 U.S.P., 2, 302, 823.
- 38 B.P., 560, 988.
- 39 U.S.P., 2, 302, 733.
- 40 U.S.P., 2, 321, 787.
- 41 *J. Soc. Dyers Col.*, 1935, **51**, 51.
- 42 *Chemical Reviews*, 1945, **36**, 291.
- 43 B.P., 566, 740-1.
- 44 *Reports of the Progress of Applied Chemistry*, 1942, **92**.
- 45 *M. Sc. Tech., Thesis, Bombay Univ.*, 1945.
- 46 Hasse, *Textilber.*, 1943, **24**, 277.
- 47 *J. Soc. Dyers Col.*, 1945, **61**, 85, 87, 88.
- 48 French, *Amer. Dyestuff Rep.*, 1945, **34**, 252.
- 49 Krähenbühl, *Textilber.*, 1943, **24**, 315.
- 50 Sklar, *J. Chem. Phys.*, 1937, **5**, 669; Branch and Calvin, *The Theory of Organic Chemistry*, 1941, p. 155; Lewis and Calvin, *Chem. Rev.*, 1939, **25**, 273; Remick, *Electronic interpretations of organic chemistry*, 1943, p. 143.
- 51 Pai and Venkataraman, *J. Sci. Ind. Res.*, 1943, **1**, 298.

PLASTICS

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PLASTIC industry has made phenomenal progress in the past few years with the development of a host of new synthetics such as the silicones, nylons, polythenes, perspex, etc. In India, due entirely to the absence of a flourishing chemical industry and consequent dearth of basic raw materials, the field of synthetic resins has hardly been touched. But the emergency conditions during the war have led to the development of a number of natural resin plastics and semi-synthetics in the country, which have found useful industrial applications in many fields.

Moulding Powders

Plastics from Horn Wastes.—Horns and hoofs serve as raw materials for an important cottage industry in India engaged in turning out a variety of utility articles. The wastes in this industry resulting from machining operations, in the form of dust, shavings and chips, have been utilized for the production of an indigenous moulding powder designated as SHP-71, in the Laboratories of the Council of Scientific and Industrial Research¹. Determination of the physical constants such as mechanical and dielectric strength, water resistance, etc., indicated a variety of uses to which the moulded articles could be put. The process has been patented² and leased out for exploitation to a South Indian firm.

Plastics from Bhilawan.—A systematic investigation into the constitution of bhilawan-nut shell oil (commonly known as marking-nut) in the Laboratories of the Council of Scientific and Industrial Research, revealed that it contained certain active ingredients which could be readily polymerized to form resins³. This has led to the production of a variety of moulding compositions suitable for compression and injection moulding. The processes of manufacture have been standardized, patented⁴ and the products tested both under laboratory and factory conditions with satisfactory results.

Plastics from Bagasse.—Hydrolysis of bagasse under controlled conditions carried out in the Council Laboratories yielded a product, which on subsequent treatment with suitable plasticizers could be moulded

into utility articles⁵. The process has been covered by a patent⁶ and is being utilized by industry.

Lignite Plastics.—Lignite resin has been extracted from Indian lignite coal which is found in abundance in Bikaner State. This resin has been utilized for the production of moulding powders and varnishes, and the exhausted coal has been briquetted for fuel purposes. This work was also conducted in the Laboratories of the *Council of Scientific and Industrial Research*, for the State.

Plastics from Vegetable Oils and Oil Seed Cakes.—Vegetable oils have been employed for the preparation of plastic moulding powders at the *University College of Science, Calcutta*. The process has been covered by a patent⁷ and a Limited concern has been floated for large-scale exploitation of the products. At the same time, work has been carried out in the Laboratories of the *Council of Scientific and Industrial Research*, for the preparation of plastics from oilseed cakes. Efforts in this direction have met with success in the production of opaque as well as translucent moulded articles from ground-nut cake, for instance. Groundnut oil is also being investigated in these laboratories for the production of plastics.

Shellac Moulding Powders.—A serious obstacle to the large-scale production of general utility articles and electrical moulded goods from shellac has been the comparatively long time-cycle of moulding involved in all thermoplastic materials. Some very important investigations to remove this defect have been carried out at the *Indian Lac Research Institute, Ranchi*, and various modified shellac compositions have been evolved. Fast rate of production, almost equal to that of bakelite mouldings, has been claimed for the modifications of shellac with formaldehyde and urea⁸, and formaldehyde and melamine⁹.

Particular mention may be made of the improvement in water resistance of shellac powders obtained by the incorporation of small percentages of cashew shell oil¹⁰. In a typical case, the water absorption was of the order of 0.4–0.5 per cent. in 24 hours. Among other modifications of shellac moulding powders evolved at the *Lac Research Institute* may be mentioned the shellac-casein¹¹, shellac-vegetable proteins¹², shellac-rubber latex¹³ and shellac-coal tar¹⁴ compositions. Some of these developments are being industrially exploited.

Plastics from Coffee-beans and Coffee-husk.—Owing to restricted export conditions during the war, the *Coffee Planters' Association* in 1940 apprehended a large amount of coffee surplus and approached the *Board of Scientific and Industrial Research* to explore the possibilities of producing moulding powders from surplus stock. Processes have since then been developed for the manufacture of moulding powders not only from coffee beans but also from coffee husk. These powders have been found suitable for moulding tough, strong and water-resistant articles of good finish.

Jute Plastics.—Prof. B. C. Guha has had considerable success in the utilization of waste products of the jute industry for the production of thermosetting plastic (Jutelite)¹⁵. The process has been covered by a patent¹⁶.

Casein Plastics.—Dr. Habib Hassan of Hyderabad, Deccan, has contributed considerably to the development of casein plastics in the State.

Water Hyacinth Plastics.—Dr. A. Karim of the Industries Department, Bengal, has developed a process for the manufacture of plastic materials from water hyacinth, the most serious pest of agricultural areas in Bengal.

Laminated Products

Aqueous alkaline dispersions and spirit solutions of natural resins together with suitable hardening agents have been successfully employed for impregnating jute cloth, cotton cloth, paper, etc., for the production of laminated sheets and boards, including corrugated boards, at the Laboratories of the *Council of Scientific and Industrial Research*¹⁷. Sandwiched boards have also been produced, in which a filling of cheaper materials such as impregnated jute waste, is used with outside laminations consisting of more decorative fabric. These products have found extensive fields of application in industry such as, for example, light building material for the construction of partitions, material for electrical accessories and switchboards, identity discs, piston ring jigs, tea-chests, sliver cans and other utility ware. A large paper factory is commercially exploiting the process for making paper laminates and other products.

Reference may be made here to the jute fabric-shellac laminates, termed "Jutlac"¹⁸,

developed at the laboratories of the *Indian Jute Mills Association, Calcutta*. In this process, instead of impregnating the laminates with a solution of the resin, molten shellac is applied to the laminate surface in a continuous manner with the help of hot rollers¹⁹. The product has been commercially used for making tea-chests, grease-drums, containers for dry goods, etc. It has also been used by the British and American Military and Air Force services.

Alcoholic solution of resin obtained by the modification of shellac and formaldehyde with urea or melamine, has been used at the *Indian Lac Research Institute* for the preparation of laminated boards²⁰. These boards have been claimed to possess remarkable mechanical and shock-resistant properties in addition to low water absorption.

Plastic Containers

Considerable attention has been paid to the development of suitable techniques for the production of containers from plastic materials particularly from laminates, under the general stress of war-time shortage of sheet metal of different types. The *Council Laboratories* produced a wide range of plastic containers from laminates, which included petrol containers of different capacities up to 4 gallons for transport purposes, and various other types²². Petrol containers were also developed from plywood²³ at the *Forest Research Institute*, for which the proofing compositions were supplied by the *Council Laboratories*. One of the outstanding developments of the latter laboratories was the so-called unburstable containers designed for dropping petrol, oil and other liquid supplies, without the use of parachutes, from low flying aircraft to troops stranded in inaccessible war zones^{22, 24}.

Difficulties of procuring heavy hydraulic equipment, necessary for the above-mentioned processes, led to the development of simpler processes, better adapted to cottage industry processing, which found particular application in the production of 4-gallon petrol containers of satisfactory design. Jettison tanks of large capacity upto 70 gallons were also dealt with, which could be prepared in the field from canvas bags and powdered resin compositions simply with the help of water and a bicycle pump. Metal-less collapsible tubes were also developed in these laboratories suitable for packing medicinal jellies, ointments, greases, etc.

Synthetic rubber jelly used in the manufacture of self-sealing fuel tanks in American aircraft was successfully substituted by an indigenous product²² made from vegetable oils. Actual firing trials on the laboratory-made tanks at normal and subzero temperatures proved quite successful.

Mention may also be made here of other plastic-cum-fabric products, which included fuel pump diaphragms and petrol-proof rubberless hose-pipes for use in internal combustion engines, developed in the Laboratories of the *Council of Scientific and Industrial Research*. The process for fuel pump diaphragms has been released for exploitation to a local firm for civil, as well as military purposes.

Drawn Laminated Mouldings

Development of container manufacture as described above in the *Council Laboratories*, subsequently led to the perfection of a process²² of drawn laminated mouldings which enabled plastic impregnated laminates to be drawn and moulded in one operation into containers of intricate shapes. The process applied equally well to both thermo-setting and thermo-plastic compositions and combined the techniques of metal sheet drawing, powder mouldings and laminate pressing. It has the advantage that the articles produced are much stronger weight for weight and much lighter strength for strength, as compared with metal products or powder mouldings. Apart from simple shaped containers for shoe polishes, dentifrices, ointments, jellies, cigarettes, etc., it has been possible to produce intricate shaped articles such as ash-trays, electrical mouldings, ceiling roses, etc. All the possibilities of the process have not yet been fully realized in practice, and work on further improvements in technique and mould design is in progress. Indian patents have been issued²¹ and British and American patents are pending. Novel features for producing raised lettering in different colours in the same pressing operation on the mouldings and special hinge-spring combinations for cigarette cases have also emanated from this development, and form subject matter for separate patents.

Artificial Fibres

Artificial wool-like fibres from groundnut cake proteins have been developed in the Laboratories of the *Council of Scientific and Industrial Research*.

Press Boards

Based on the results of preliminary laboratory investigations carried out at the *Coconut Research Station, Colombo*, the *Forest Research Institute, Dehra Dun*, has developed a process for the manufacture of hard press-boards designated "Coconite"²⁵ from immature coconuts. "Coconite" which has been found to possess excellent heat and sound insulating properties, may find application for the panelling of railway coaches. Experiments have also established the suitability of coconite for the construction of gin-washers extensively used in the textile industry.

At the same time satisfactory shock-proof padding material²⁶ useful for mounting delicate parts of machinery has been produced from coconut coir fibre in the laboratories of the *Council of Scientific and Industrial Research*. The process has been covered by a patent²⁷.

Resin Impregnation of Wood

Among the methods employed for improving the physical properties of wood and thereby overcoming its deficiencies, considerable attention has been paid to resin impregnation. A large amount of work using synthetic resins has been done on this subject at the *Forest Research Institute, Dehra Dun*. Various shellac compositions have also been worked out in the Laboratories of the *Council of Scientific and Industrial Research*, for impregnating bobbins used in jute and cotton mills²⁸. Treated bobbins tested under controlled conditions in mills have shown sixteen-fold improvement in service life. Shuttle blanks, handloom bamboo reeds and gramophone fibre needles have also been treated with good results.

Adhesives and Cements

A fairly large number of adhesives and cements required for specific purposes made from indigenous materials have been prepared at the *Indian Lac Research Institute* and the *Laboratories of the Council of Scientific and Industrial Research*. A particular cement²⁹ for joining glass to glass and porcelain, glass to metal and metal to metal, developed at the *Lac Research Institute* from shellac acids, has been claimed to withstand steam or boiling water for 6-8 hours or even more, without affecting its adhesive characteristics. Adhesives from shellac developed at the *Council Laboratories*, and from casein at the *Forest Research Institute* for

use in plywood industry have been investigated and improvements as regards adhesion, strength, and resistance to cold and boiling water have been affected. The *Council Laboratories* have also produced dry ready-mixed casein glues suitable for plywood and general woodwork, which only need to be mixed with water at the time of use to yield good water-resistant joints.

Compositions for the manufacture of abrasive paper, grinding wheels, and insulating tapes used in the electrical industries, have also been developed at the *Lac Research Institute*³⁰.

Among the various types of cements to suit specific purposes developed at the *Council Laboratories*, may be mentioned (1) crown cork cement for cementing cork sheet washers to metal crown caps, (2) petrol-proof patching cement, (3) heat-resistant cement for electric lamps and radio valves and (4) petrol tank sealing composition³¹.

Chemicals Used in the Plastic Industry

Of the raw materials used in the plastic industry, perhaps the most important ones are phenol, urea and formaldehyde. Phenol and crysilic acid are being manufactured by a couple of firms in India, but the output is so meagre that it cannot meet the demand of the plastics industry.

Pilot plant experiments on the catalytic oxidation of methyl alcohol to formaldehyde have been carried out at the *Indian Institute of Science, Bangalore*, and a full-scale pilot plant has been erected at the Institute.

Optimum conditions for the preparation of thiourea³², and melamine and urea from calcium cyanamide²⁰ on a small but profitable scale have also been established to meet the requirements of the shellac moulding powder industry.

Pilot plant investigations for the manufacture of furfural, a chemical largely used in the plastic industry, from agricultural wastes like bagasse, rice husk and corn-cobs, have been carried out in the *Laboratories of the Council of Scientific and Industrial Research*. These laboratories have also been successful in producing sebacic acid from castor oil, which forms an important raw material for the nylon type of resins.

References

- ¹ Bhatnagar S. S., Joga Rao A. and Verman Lal C., *J. Sci. and Ind. Res.*, 1944, 2, 166.
- ² Bhatnagar S. S., Joga Rao A. and Verman Lal C., *Ind. Pat.* No. 31282 (1944).

- 3 Siddiqui S., *J. Sci. & Ind. Res.*, 1942, 1, 19.
- 4 Siddiqui S. and Azhar Ali Khan, *Ind. Pat. Nos.* 28002-5 and 28424 (1941), 29051 (1942), 29938 (1943).
- 5 Prakash Narain and Bhatnagar S. S.; *J. Sci. Ind. Res.*; 1945, 3, 396.
- 6 Prakash Narain and Bhatnagar S. S.; *Ind. Pat. No.* 28428 (1941).
- 7 Goswami M. N.; *Ind. Pat. No.* 24817 (1938).
- 8 Venugopalan and Sen H. K.; *British Plastics*; 1939, 10, 626.
- 9 Sankaranarayanan and Sen H. K.; *Ind. Lac Res. Inst., Note No.* 22; 1940.
- 10 *Annual Report, Ind. Lac Res. Inst.*, 1941.
- 11 Venugopalan and Sen H. K.; *Ind. Lac Res. Inst., Note No.* 21, 1940.
- 12 *Annual Report, Ind. Lac Res. Inst.*, 1942.
- 13 *Annual Report, Ind. Lac Res. Inst.*, 1941.
- 14 Venugopalan and Sen H. K.; *Ind. Lac Res. Inst., Note No.* 23, 1940.
- 15 Noder C. R.; *J. Sci. & Ind. Res.*, 1945, 4, 128.
- 16 Indian Central Jute Committee, *Ind. Pat. No.* 29525 (1943).
- 17 Bhatnagar S. S., Verman Lal C. and Khan C. A. R.; *Ind. Pat. Nos.* 28277, 28281 (1941).
- 18 Macmillan, W. G., *Curr. Sci.*, 1945, 14, 209.
- 19 Ind. Jute Mills Assoc., *Ind. Pat. Nos.* 28934, (1942); 29370 and 29628 (1943).
- 20 *Practical Applications of Recent Lac Research*; Ind. Lac Res. Inst., 1940.
- 21 Bhatnagar S. S., Khan C. A. R. and Verman Lal C., *Ind. Pat. Nos.* 30680 and 32824 (1944).
- 22 *J. Sci. and Ind. Res.*, 1944, 2, 109.
- 23 *J. Sci. and Ind. Res.*, 1944, 2, 113.
- 24 Bhatnagar S. S., Prem Prakash and Verman Lal C., *Ind. Pat. No.* 28427 (1941).
- 25 *J. Sci. and Ind. Res.*, 1944, 2, 172.
- 26 *J. Sci. and Ind. Res.*, 1944, 2, 174.
- 27 Bhatnagar S. S., Ali Ahmad and Bhatia V. S., *Ind. Pat. No.* 29400 (1943).
- 28 Bhatnagar S. S., Verman L. C., Karim S. M. and Joglekar G. D., *Ind. Pat. No.* 27714 (1940).
- 29 *Annual Report, Ind. Lac Res. Inst.*, 1943-44.
- 30 *Annual Report, Ind. Lac Res. Inst.*, 1943-44.
- 31 Atma Ram, Bhatnagar S. S. and Verma M. R., *Ind. Pat. No.* 31283 (1944).
- 32 Sen H. K., Bhoomik and Ghose, *Ind. Lac Res. Inst., Note No.* 31, 1943-44.

VEGETABLE OILS

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APPLIED Research in vegetable oils in India during war-time (1939-45) has followed two main lines of approach as in other parts of the world, one along normal channels as during peace-time, and the other with a specific purpose of tackling problems arising out of the war. Most of the papers published during this period have dealt with the component fatty acid analysis of fats not previously examined, and it is only recently that investigators have turned their attention to such subjects as the utilization

of fats and their by-products by sheer war-time necessity. Considering that India is the world's largest producer of oil seeds with a total production of over 8 million tons annually, the sum total of applied research on oilseeds, oils and oilcakes in India compares very poorly with the volume of work done in other countries, and it is hoped that the impetus given by the war will result in very much more work being done in future years. The starting of the *Council of Scientific and Industrial Research*, Delhi, and the creation of a Vegetable Oil Committee are very welcome steps.

General

R. G. Gupta¹ has reviewed the position of oilseeds and vegetable oils of India and B. L. Manjunath² has dealt with castor oil and its utilization.

The extraction of castor seed or cake by using industrial alcohol is recommended by N. G. Chatterjee³.

Component Fatty Acids

Several papers have been published on the component fatty acids of fats previously not examined, and in a few cases the glyceride structure has also been studied. The fats analysed are as follows:—

- N. L. Vidyarthi and C. S. Dasa Rao⁴—*Garcinia Indica* (Kokum butter);
- N. L. Vidyarthi and M. Narsingarao⁵—Wax from sugarcane.
- P. K. Bose and S. N. Dutt⁶—Oil from fruits of *Ferula Alliacea*, Boiss.
- N. L. Vidyarthi and M. Venkatesh Mallaya⁷—Nigerseed oil.
- S. V. Puntambekar and S. Krishna⁸—Seed fat of *Bauhinia Variegata*, Linn.
- S. V. Puntambekar and S. Krishna⁹—*Solanum Indicum*, Linn.
- N. N. Godbole, B. G. Gunde and P. D. Srivastavi¹⁰—Seed fat of *Buchanania Lati-folia* (Chiranjii).
- J. W. Airan and S. V. Shah¹¹—*Momordica Sp.*
- J. W. Airan and S. V. Shah¹²—Seed fat of "Star anise."
- B. S. Nagaraj¹³—*Xylia Xylocarpa*.
- S. V. Puntambekar¹⁴—Seed fat of *Prinsepia Utilis*, Royle.
- S. V. Puntambekar¹⁵—*Mallotus Philippi-nensis*, Muel.
- N. L. Vidyarthi¹⁶—Safflower oil (glyceride structure).
- C. Venkat Rao, M. Narsing Rao¹⁷—*Vateria Indica*.

- C. Venkat Rao, M. Narsing Rao and A. Venkateswaralu¹⁸—Tobacco Seed Oil.
 C. Venkat Rao, M. Narsing Rao and A. Venkateswaralu¹⁹—*Bombax Malabaricum*.
 R. Child and W. R. N. Nathaniel²⁰—Margosa (Neem oil).
 C. Venkat Rao, M. Narsing Rao and A. Venkateswaralu²¹—Tobacco Seed Oil.
 M. A. Saboor²²—Seed fat of *Lophera Alata*.
 R. H. Siddiqui and S. M. Ali²³—Fat of *Streptogonopus phipsoni millipedes*.

Characteristics, Reactions and Chemistry of Fats

J. C. Das and N. K. Mullick²⁴ have examined the constants of mustard oil, and U.S. Kini²⁵ has reported on the physical properties and chemical characteristics of South Indian shark and skate liver oils. The aroma and flavour of butter and ghee have been investigated by J. B. Lal and A. P. Sharma²⁶. N. V. Subba Rao and J. V. B. Rao²⁷ have described an unusual occurrence of large quantities of free fatty acids in the cake of *Pongamia glabra*. Ghulam Farid²⁸ has determined the specific heats and other physical constants of some Indian oils.

On the fundamental side, P. C. Mitter and P. N. Bagchi²⁹ have synthesised Δ^6 hexadecenoic acid from oleic acid and further work on long chain acids has been published by P. C. Mitter and B. K. Bhattacharya³⁰. Interesting work has been done by Bawa Kartar Singh³¹ on the optical activity and structural patterns of glycerides, while M. Pancholy, A. Pande and S. Parthasarathy³² have studied ultrasonic velocities in vegetable oils with a view to eliciting a relationship between chemical constitution and sound velocity. The kinetics of the hydrogenation of oils in a continuous process forms the subject matter of a paper by R. V. Joglekar and S. K. K. Jatkar³³. T. N. Mehta, V. S. Mehta and V. B. Thosar³⁴ have studied the halogenation of fatty acids.

Methods of Analysis

In the field of analysis, attention has been mainly directed towards evolution of better methods of detecting adulteration in ghee. M. C. Muthanna and B. Mukerjee³⁵ find that adulteration in ghee can be detected by ultraviolet fluorescence technique, while G. Narashima Murthy and V. V. Suryanarayan Murthy³⁶ are of the opinion that the method is not reliable. P. N. Sen Gupta³⁷ has suggested the adoption of the oxidation value of

Alexander as modified by him for the detection of adulteration in ghee, while J. C. Das and N. K. Mullick³⁸ have emphasized the significance of phytosteryl acetate, and P. N. Sen Gupta³⁹ the importance of Kirschner value, for the same purpose.

The precipitability of milk proteins under different conditions has been made use of for a rapid method of differentiating cow's milk by N. K. Basu⁴⁰.

V. S. Govindrajan⁴¹ has compared the relative merits of different methods for the determination of iodine values and has recommended the Rosenmund and Kuhnheim's method as being the best.

Rancidity and Edible Fats

It is interesting to note that the subject of rancidity is getting more attention from workers in India than during the previous years. S. V. Govindrajan and B. N. Banerjee⁴² have studied the antioxidant properties of several substances and recommend the use of "Kamala" dye for prolonging the period of induction in butter fat.

V. Krishna Murthi and C. J. Dasa Rao⁴³ have compared the rancidity of solvent extracted and expressed oil and find that the difference is due to a difference in the gossypol content. The addition of 4 per cent. creosote or hydroquinone to improve the keeping qualities of *Hydnocarpus Wightiana* oil is recommended by U. P. Basu and Majumdar⁴⁴. W. L. Davies⁴⁵ has published a note on the antioxygenic effect of cereal flour paste as coating on contact wrappers for fatty foods, and J. S. Agarwal⁴⁶ has studied the effect of storage in different containers on Indian vegetable fats.

The changes in the physical and chemical constants of ghee in prepared foods consequent on storage have been described by J. C. Das and N. K. Mullick⁴⁷.

Soaps, Fatty Acids, Sulphonated Oils and Textile Assistants

The manufacture of substituted soaps as textile assistants from indigenous vegetable oils has been studied by C. B. Patel⁴⁸, Venkatraman and Uppal⁴⁹, Mehta and Trivedi⁵⁰, and Desai and others⁵¹. S. R. Palit⁵² has studied the dissolution of soap in mixed solvents.

In this connection, two patents have been taken—Patent No. 30679, on foam generating substances by A. Ram, S. S. Bhatnagar, A. Jogarao, Karimullah and L. C. Verman⁵³ and Patent No. 29937, on

a new process for the manufacture of arylamides of fatty acids from Indian vegetable oils by R. D. Desai and R. C. Shah⁵⁴.

Drying Oils, Driers, Polymerized Products

M. Ajmani and S. K. K. Jatkar⁵⁵ have studied the activity of driers at high temperatures and V. S. Ramanathan⁵⁶ the effect of lead and manganese driers on the tensile strength of cloth. B. V. Bhide and N. L. Phalnikar⁵⁷ have examined the heat polymerization of oils with reference to cracking, and S. A. Saletore and R. K. Shrivastav⁵⁸ have studied the suitability of polymerized safflower oil for the manufacture of oil cloth. There have been three patents, all of them connected with varnishes for coating fabrics. Patent No. 31284 by M. Qureshi and T. U. Subba Rao⁵⁹ deals with varnish from castor oil products; Patent No. 30944 from the Government Industrial Laboratory⁶⁰, Hyderabad (Dn.) is for applying to a fabric a composition prepared from a mixture of nitrated and sulphonated vulcanized oils, and Patent No. 29968 by M. Qureshi and T. V. S. Rao⁶¹ deals with waterproof and gasproof fabrics from castor oil products.

Fuels, Illuminants, Lubricating Oils

The exigencies of war have stimulated research for finding vegetable oil substitutes for fuel oil and lubricants of mineral origin. N. M. Dalal and T. N. Mehta⁶² have studied the cracking of vegetable oils, for use as liquid fuels. Two bulletins have been published by the Industrial Research Bureau, one on vegetable oils as lubricants⁶³ and the other on the use of vegetable oils as fuel for I. C. engines⁶⁴. S. S. Bhatnagar, J. S. Agarwal, G. D. Joglekar and Lal C. Verman⁶⁵ have published data regarding the use of vegetable oils for illumination purposes and C. K. Nijhawan⁶⁶ has patented a process for burning mustard oil in lanterns.

By-products Utilisation

The last few years have seen an increasing attention being paid in India to the utilization of the by-products of the oil milling industry. S. R. K. Menon⁶⁷ has described the manufacture of "Coconite" from coconut husk and resin separated from the same, and A. N. Bindal and M. Srinivasaya⁶⁸ have made a comparative study of the brans, husks, oil cakes, etc., as raw materials for the production of diastase.

V. R. Bhalerao and S. A. Saletore⁶⁹ have examined the edibility of groundnut cake

and the Swastik Oil Mills⁷⁰ have patented a process for the preparation from groundnuts of a product suitable for human consumption and its application for the manufacture of confectionery.

The utilization of groundnut meal has also been studied by U. P. Basu and S. K. Sen Gupta⁷¹.

P. N. Chowdhury⁷² has patented a method for the manufacture of potassium carbonate and caustic potash from castor seed husks.

References

- 1 *J. Inst. Chem. (India)*, 1942, **14**, 49.
- 2 *J. Sci. Ind. Res.*, 1943, **1**, 225.
- 3 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1933, **2**, 171.
- 4 *J. Ind. Chem. Soc.*, 1939, **16**, 437.
- 5 *Ibid.*, 1939, **16**, 134.
- 6 *Ibid.*, 1940, **17**, 49.
- 7 *Ibid.*, 1940, **17**, 87.
- 8 *Ibid.*, 1940, **17**, 96.
- 9 *Ibid.*, 1941, **18**, 329.
- 10 *Ibid.*, 1941, **18**, 557.
- 11 *J. Univ. Bombay*, 1942, **11A**, 105.
- 12 *J. Ind. Chem. Soc.*, 1942, **19**, 175.
- 13 *J. Mys. Univ.*, 1942, **3B**, 105.
- 14 *J. Ind. Chem. Soc.*, 1942, **19**, 464.
- 15 *Curr. Sci.*, 1942, **11**, 464.
- 16 *J. Ind. Chem. Soc.*, 1943, **20**, 45.
- 17 *J. Ind. Chem. Soc.*, 1943, **20**, 239, 298.
- 18 *Ibid.*, 1943, **20**, 374.
- 19 *Ibid.*, 1943, **20**, 403.
- 20 *Ibid.*, 1944, **21**, 35.
- 21 *Ibid.*, 1944, **21**, 249.
- 22 *Ibid.*, 1944, **21**, 303.
- 23 *Ibid.*, 1944, **21**, 134.
- 24 *J. Inst. Chem. (India)*, 1944, **16**, 70.
- 25 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1944, **7**, 32.
- 26 *J. Inst. Chem. (India)*, 1945, **17**, 55.
- 27 *J. Ind. Chem. Soc.*, 1940, **17**, 526.
- 28 *Sci. & Cult.*, 1941, **6**, 617.
- 29 *J. Ind. Chem. Soc.*, 1941, **18**, 461.
- 30 *Ibid.*, 1942, **19**, 69.
- 31 *J. Sci. Ind. Res.*, 1944, **2**, 223.
- 32 *Ibid.*, 1944, **3**, 111.
- 33 *J. Ind. Chem. Soc.*, 1941, **18**, 631.
- 34 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1940, **3**, 166.
- 35 *Curr. Sci.*, 1940, **9**, 120, 235.
- 36 *Ibid.*, 1940, **9**, 334.
- 37 *J. Inst. Chem. (India)*, 1943, **15**, 103.
- 38 *Ibid.*, 1944, **16**, 132.
- 39 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1943, **6**, 153.
- 40 *J. Inst. Chem. (India)*, 1942, **14**, 114.
- 41 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1940, **3**, 192.
- 42 *Curr. Sci.*, 1939, **8**, 559.
- 43 *Ibid.*, 1940, **9**, 75.
- 44 *J. Ind. Chem. Soc.*, 1940, **17**, 280.
- 45 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1940, **3**, 174.
- 46 *J. Ind. Chem. Soc.*, 1942, **19**, 121.
- 47 *J. Inst. Chem. (India)*, 1942, **14**, 66.
- 48 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1939, **2**, 112.

- 49 *J. Soc. Dyers & Col.*, 1939, **55**, 125.
- 50 *Ind. Sci. Cong.*, 1939, **26**, 76, 77.
- 51 *Ibid.*, 1939, **26**, 62.
- 52 *J. Ind. Chem. Soc.*, 1942, **19**, 271.
- 53 *Ind. Pat.* No. 30679.
- 54 *Ind. Pat.*, No. 29937.
- 55 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1940, **3**, 207.
- 56 *Ibid.*, 1944, **7**, 133.
- 57 *J. Ind. Chem. Soc.*, 1944, **21**, 313.
- 58 *Private Communication*.
- 59 *Ind. Pat.*, No. 31284.
- 60 *Ind. Pat.*, No. 30944.
- 61 *Ind. Pat.*, No. 29968.
- 62 *J. Ind. Chem. Soc., Ind. & News Edn.*, 1939, **2**, 41, 213.
- 63 *Industrial Res. Bull.*, No. 18, 1940.
- 64 *Ibid.*, No. 19, 1940.
- 65 *J. Sci. Ind. Res.*, 1944, **2**, 175.
- 66 *Ind. Pat.*, No. 31254.
- 67 *J. Sci. Ind. Res.*, 1944, **2**, 172.
- 68 *Ibid.*, 1944, **3**, 245.
- 69 *Private Communication*.
- 70 *Ind. Pat.*, No. 31345.
- 71 *J. Ind. Chem. Soc.*, 1944, **21**, 389.
- 72 *Ind. Pat.*, No. 30720.

GLASS

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GLASS manufacture in India, throughout the half century or so of its life, has undergone constant struggles to keep itself alive. Even in the years preceding the war, it had not attained technically or economically a very sound footing.

The review of progress covering the war years (1939-45), represents the efforts made during this period to expand the industry. It reflects particularly the activities of the recently started centres of glass technology, viz., the Department of Glass Technology, Benares Hindu University (started, 1937), Industrial Research Bureau, Government of India (started in 1935 and now merged with the Council of Scientific and Industrial Research), and the Glass Technology Section of the U.P. Government, Industries Department (started, 1938).

India used to import considerable quantities of glassware from abroad. With the outbreak of war, particularly with Japan in 1941, her sources of supply were cut off. This led to heavy demands on the home industry, especially as India's war effort gained momentum, and she became the supply base for operations in the Middle and Far Eastern theatres. The boom in the glass trade gave an impetus to the expansion

of the industry, despite several handicaps. Adequate technical assistance was lacking and there was severe shortage in supplies of coal, soda ash and other chemicals; transport difficulties were also considerable. Further, the machinery and plant needed for such growth could not be obtained from abroad. However, for certain types of essential or strategic glass articles, new compositions, furnaces and factory plant, methods of manufacture and testing were developed, though with varying success.

Survey and Treatment of Raw Materials *

Several papers dealing with the occurrence and quality of glass making sands, and quartzitic deposits have been recently published. The sand deposits near Bargarh have been reported in two papers, one by M. L. Misra¹ and the other by R. C. Misra². Glass making raw materials in the neighbourhood of Rajpur (Dehra Dun) and Jammu have been described by Chhibber and Misra³ while the sand deposits of Sawai Madhopur and Banmore have been investigated by Dubey and co-workers⁴. Misra⁵ has published a number of analyses of Indian feldspars. For washing glass making sands, Nadel and Saxena⁶ have designed a simple unit capable of handling up to 5 tons sand daily.

Glass Compositions

Compositions for a number of different types of glasses have been investigated by various workers. Charan⁷ published a paper on batches for copper ruby glass and Charan and Misra⁸ studied the possibility of incorporating large proportions of feldspar and *reh* in glass batches. Verma, Joshi and Gulathi⁹ have conducted trials with different batches to produce glasses of compositions similar to pyrex and other well-known brands. Nadel and collaborators¹⁰ have worked out a number of lamp working glasses of varied colours for the manufacture of glass beads, buttons, etc. Mehendale¹¹ has published the results of some experiments for making borosilicate crown glass for optical purposes.

Manufacturing Processes and Technique

The only notable publication on this subject is by Rao¹² on the manufacture of sintered glass articles such as discs and

* The Industrial Research Bureau initiated during 1936-1940 a survey of glass raw materials. The results have not so far been published.

crucibles. Glass-bead making as a cottage industry has been introduced in U.P. with the aid of Czechoslovakian bead makers employed for some time by the U.P. Government Industries Department.

Fuels and Furnaces

There has been a noticeable activity in industry for installing furnaces of improved designs. Talwalkar¹³ has published a paper dealing with high temperature laboratory furnaces, and a critical review on glass currents in continuous tank furnaces has been published by Varshney¹⁴.

Decorative Processes and Materials

Several publications on decorative compositions have been published during the period. Atma Ram, Karimullah and Verman¹⁵ developed a method of making liquid gold, and Atma Ram and Verman¹⁶ worked out suitable compositions for China glass. During the war years, these processes have been utilized on a commercial scale. Charan and Arnikar¹⁷ studied the methods of staining of glass, and Joshi¹⁸ published a note on the electrodeposition of metallic films on glass surfaces. Frosting of electric bulbs has been studied by Gupta¹⁹ while suitable conditions for ice frosting were investigated by Nadel and Hegde²⁰.

Testing

Karim and Verman²¹ published the results of thermal endurance tests on electric bulbs. Majumdar²² investigated the solution of sodium chloride in B_2O_3 glass. Agarwal and Nadel²³ have tested a number of Indian glasses for chemical durability.

Publications

A handbook of glass technology written chiefly to meet the needs of undergraduate students has been brought out by Charan²⁴, while a series of six lectures on fuels and furnaces delivered by Shaha²⁵ at the Calcutta University, has been published in a handy book form. A thought-provoking article on the future of glass industry with regard to uses of glass as a substitute for metals was read before the *Society of Glass Technology* by Atma Ram²⁶, and a survey of the present position of furnaces in the glass and ceramic industries in India has been contributed by Varshney²⁷.

Due to the stress of war conditions and urgent demands for various types of glassware not made in the country, considerable work of an investigational character has

been carried out in various laboratories, as well as in factories, but due to lack of authentic information, it has not been possible to include it within the scope of this review.

Perhaps the most important development in recent years is the decision of the *Council of Scientific and Industrial Research* to establish a *Central Glass and Ceramic Research Institute* at Calcutta. The construction of the buildings is well under way. The *Institute* will play an important part in the future development of the glass and ceramic industries in India.

References

- 1 *Sci. and Cult.*, 1938, 3, 558.
- 2 *Trans. Ind. Cer. Soc.*, 1942, 1, 169.
- 3 *Ibid.*, 1942, 1, 159; 1943, 2, 47.
- 4 *Trans. Ind. Cer. Soc.*, 1943, 2, 97; 1944, 3, 62.
- 5 *Trans. Ind. Cer. Soc.*, 1943, 2, 11.
- 6 *J. Sci. Ind. Res.*, 1944, 2, 215.
- 7 *Sci. and Cult.*, 1942, 7, 399.
- 8 *Trans. Ind. Cer. Soc.*, 1942, 1, 20; *Sci. and Cult.*, 1939, 4, 513.
- 9 *Trans. Ind. Cer. Soc.*, 1944, 3, 116.
- 10 *Publications of the U.P. Govt., Industries Dept.*, No. 6 & 7.
- 11 *Trans. Ind. Cer. Soc.*, 1942, 1, 206.
- 12 *J. Sci. Ind. Res.*, 1944, 3, 418; *Sci. and Cult.*, 1945, 11, 183.
- 13 *Trans. Ind. Cer. Soc.*, 1944, 3, 18.
- 14 *Trans. Ind. Cer. Soc.*, 1942, 1, 60.
- 15 *Indian Ind. Res. Bull.*, No. 16.
- 16 *Indian Ind. Res. Bull.*, No. 17.
- 17 *Sci. and Cult.*, 1941, 7, 160.
- 18 *Science Congress Abstracts*, 1942.
- 19 *Trans. Ind. Cer. Soc.*, 1942, 1, 15.
- 20 *Publication of the U.P. Govt. Industries Dept.*, No. 3.
- 21 *J. Sci. Ind. Res.*, 1944, 2, 92.
- 22 *J. Ind. Chem. Soc.*, 1942, 19, 241.
- 23 *Publications of the U.P. Govt. Industries Department*, No. 4.
- 24 R. Charan—*Handbook of Glass Technology*, published by the author, Benares Hindu University.
- 25 A. K. Shaha—*Lectures on Fuels and Furnaces*, published by the Calcutta University.
- 26 *Sci. and Cult.*, 1945, 10, 413, 472.
- 27 *J. Sci. Ind. Res.*, 1944, 3, 213.

REFRACTORY TECHNOLOGY

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General

PROGRESS in many major industries is interlocked with advances in refractories. It is not surprising, therefore, that an annual survey of what goes on, in the field of refractory technology, is made by a number of technical journals. A review of the progress was published in 1940 by Mitra¹.

From a perusal of the literature of the war years, it would appear that no spectacular development during this period took place, corresponding to that of the few years prior to it. A few of the outstanding developments in the immediate pre-war years were recovery of magnesia from sea water for use as refractory, stabilization of dolomite and its use in metallurgical furnaces, etc. This does not mean that research in this branch of industry has been at a standstill. Exigencies of war made it necessary to pool available knowledge in the making of a better finished product from available raw materials. Search for substitutes had to be intensified as raw materials used in the manufacture of a particular refractory became scarce or unavailable. Low grade raw materials, at one time thought to be of no value, received attention. In the construction and maintenance of furnaces, plastic materials and ramming mixes substituted bricks, as supply of refractory bricks became less abundant. Such materials also made possible quicker repairs to a furnace, which in turn cut down their idle time and helped in enhancing outturn. Ramming mixes helped to bring a new furnace into full operation in a shorter period of time. Records have been created in cutting down relining time of blast furnaces.

Manufacturing Processes

Firebricks.—About 2,775,000 tons of pig iron per lining² is now made in the U.S.A. This contrasts with the figures given for 1932 by Barret³ when on the average 800,000 tons of iron per lining was being made. He mentioned one furnace which made 1,537,934 tons at that time. Firebricks used for the record tonnages are now manufactured by the power-press-vacuum method. They are fired to about cone 18 (1,490° C.) and have greater resistance to carbon monoxide disintegration.

Silica.—"Threatened" materials or processes in industry often survive competition from the newcomer in the field. Trend in the construction of basic open hearth furnace has been to use more of basic refractory in place of silica brick. The former permits of a higher operating temperature in the furnace. A new type of super duty silica brick with low alumina content has been put on the market. It can withstand an operating temperature about 85° C. higher than those of high quality silica brick⁴.

Cyanite Brick.—Indian cyanite used in U.S.A. became scarce in that country. Native cyanite of inferior grade after processing, as also topaz, were used as substitutes^{5,6}.

Chrome Refractories.—Much needed fundamental studies on chrome ore have been made by Green and his colleagues of the *British Refractories Research Association*.

Basic Refractories.—Austria held the monopoly of magnesite refractory needed for basic steel furnaces, particularly upto the first World War. Countries likely to be affected by cutting out supplies from this source were found to be better prepared at the beginning of the second World War. Chrome-magnesite brick, magnesite from sea water and finally stabilized dolomite were extensively used particularly in England.

Basic Refractory from Low Grade Ore.—Indian reserve of chrome ore is limited. A notable Indian achievement during the past year was the utilization of a low grade chrome ore which has a P.C.E. Value of barely Cone 20 (1,530° C.) for making high grade chrome-magnesite type of brick. This has been successfully used in open hearth furnaces.

Rarer Refractories.—The reported wider use of zirconium silicates and beryllium oxide as refractories is of interest as both are found in India.

Improved Techniques

Relining of Blast Furnaces.—Remarkable strides have been made in cutting down the time of relining a blast furnace, from several months to only three weeks⁷. This has been made possible by removing salamander through holes burnt in the hearth jacket into brick-lined railroad cars, extensive use of mechanical appliances and lining more than one section of the furnace simultaneously. A swinging scaffold has been designed.

Repairs to Blast Furnace Stove.—Hoffman⁸ describes major repairs to main and secondary arches and checker rider supporting the checker work of a blast furnace stove. Ordinarily, this job would have entailed removal of the entire checker bricks and affected the production of the blast furnace. He describes how the entire checker work was supported by cables and timber. The entire work was done in a fraction of the time normally required. It helped saving brick.

High Temperature Concrete, Ramming Mix, Etc.

Instead of using ready-made brick and shapes from the manufacturers' plant, the desired lining material was fabricated at the point of use by more extensive employment of high temperature cement and concrete.

Ludberg⁹ describes the use of such cement for coke oven door, ascension pipes, etc.

Cyanite base quick setting ramming mixes have been successfully used in India for lining O. H. furnace doors. Life obtained was 50 per cent. more compared to fire-brick normally used for the purpose.

The conventional method of making the bottom of a basic open hearth furnace is to burn in about 12" of a mixture of 'Pea' magnesite and slag on magnesite brickwork. The process is laborious and takes about three weeks' time. Ramming mixes have recently been substituted for such a purpose, particularly in U.S.A. A ramming mix of Indian make has been successfully used in making several open hearth furnace bottoms in this country. Nine inches of this rammed composition was first used over magnesite brickwork. This was then covered with the conventional three inches of "burnt in" material. The time thus saved in bringing the furnace to full operation was of the order of two weeks.

New Design of Furnace

A new design of furnace was made possible by the use of permeable refractories. Waste gases from the furnace are drawn through permeable refractory, i.e., an open textured insulating brick, into a flue before going to the chimney. It makes uniform distribution of heat as also saving in fuel possible. Anderson, Gunn and Roberts¹⁰ describe such a furnace.

Testing and Research

Besides the petrographic microscope and X-ray, a new research tool, viz., electron microscope is now available. Smith¹¹ has described an electron microscope and its application in the ceramic industry.

References

- ¹ Mitra, *Proc. Inst. Chem. (India)*, 1940, **12**, 95-119.
- ² *Private Communication*, Harbison Walker Refractories Co., Pittsburgh.
- ³ Barrett, *Blast Furnace and Steel Plant*, 1933, **21**, 123.
- ⁴ Brashares, *Iron and Steel Eng.*, 1943, **20**, 48.
- ⁵ McVay and Wetson, *J. Amer. Cer. Soc.*, 1943, **26**, 252.

⁶ McVay, Gallreath and Allen, *J. Amer. Cer. Soc.*, 1944, **27**, 275.

⁷ *Blast Furnace and Steel Plant*, 1942, p. 1395.

⁸ Hoffman, *Blast Furnace and Steel Plant*, 1945, **33**, 838.

⁹ Ludberg, *Ibid.*, 1945, **33**, 830.

¹⁰ Anderson, Gunn and Roberts, *J. Inst. Fuel*, 1944, **17**, 169.

¹¹ Smith, *J. Canadian Ceram. Soc.*, 1945, **14**, 37.

COAL RESEARCH

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INTEREST in India on fuel research at present centres round our solid fuel resources, coal in particular. Researches on coal in India has lagged behind that of the other countries and in this brief review mention is made of only the outstanding advances produced by the more novel type of researches in other countries.

The subject of coal research may be broadly classified into three groups, viz., (a) coal constitution and properties, (b) gasification, and (c) hydrogenation. The first has influence in varying degrees on all the problems of coal research, the second has bearing on heavy industries in general and has been studied for over a century, and the third group has led to important technical advances in various fields of chemical industry.

Coal Constitution and Properties

The greater amount of fundamental research on coal¹ has been aimed at acquiring a knowledge of the complex molecular aggregate which goes to form the coal substance. The methods that have been used are chemical, physical and petrological and include solvent extraction, oxidation, reduction, hydrogenation, halogenation, artificial coalification, petrological classification, study of porosity and surface, particle size determinations, X-ray diffraction, radiography, thermal distillations, chromatographic analysis², etc.

Hitherto the greater amount of coal research has been more or less chemical in nature, but the trend of coal research during the war years has veered more towards the physical and especially the colloidal aspect of coal.

The properties of solids depend on the nature of structural units and on the cohesive forces between them. Further, when more than one kind of structural unit is present, the bulk behaviour of the whole depends on

the combined properties of the units of different kinds and sizes. It is towards these different units and sizes of units, especially of the smallest and of colloidal size, that the attention of workers has been directed.

Coal is now recognized to be a naturally occurring heterogeneous type of organic high polymer (some have even conceived it to be an isogel). The potential value of research on the colloid structure of coal from the fundamental and industrial points of view is, therefore, obvious.

It has been said that every advancement in science is an advancement of method. In fact, every method of chemical and physical investigation is being brought to bear on the complex problem of the structure and constitution of coal.

Attempts at determinations of the internal surface area of coal and the nature and dimensions of the pores and capillaries by the measurement³ of "heat of wetting" of coals in methanol (Bangham) and from studies of porosity (King, *et. al.*)³ have yielded valuable results and have abundantly helped in the classification of coal from the standpoint of their industrial utilization. Results of investigation of the micellar strength of coals determined by adsorption methods and their correlation with the result of mechanical tests, have led to important conclusions regarding the relation between the rank and structure of a given coal and its strength and reactivity when it is carbonized.

Inherent moisture (Dunningham)³ condensed on the internal surface of coal has been co-related with the rank of the fuel and seems to provide a useful basis for the assessment of coking and swelling properties, reactivity, dust proofing, etc. It has also been possible to correlate this quantity of inherent moisture with the chemical constitution and industrial performance of coals.

From theoretical consideration of adsorption isotherms, Maggs³ has developed the following equation for the calculation of FA and $F\Sigma$:

$$FA = \frac{RT}{S_1} \int_0^{p_1} s \, d \log e \, p$$

$$F\Sigma = \frac{RT}{M} \int_0^{p_1} s \, d \log e \, p \quad \dots \dots \dots (1)$$

the integration on the right hand side being performed graphically.

In these equations, F —surface pressure of adsorbed film; A —area occupied per mole of adsorbate; Σ —internal area of adsorbent per gram; S —number of gm. of adsorbate taken up per gm. of adsorbent at pressure P ; and M —mol. wt. of adsorbate. These equations have been used by Gregg to calculate the monolayer capacity of a given fuel from the adsorption isotherm of a gas and vapour on the solid by the following equation:

$$S_0 = \frac{M \Sigma}{A_0} = \frac{M}{\text{slope}} \dots \dots \dots (2)$$

where A_0 —incompressible area of the adsorbate per mole. In all the considerations of the fine structure of coal the monolayer capacity is assuming paramount importance.

The ultra-fine structure of coal in all its aspects appears to have the closest relation upon the behaviour of the material when it is carbonized and thus a knowledge of this structure should lead to a better selection of coal for carbonization purposes. The measurement of electrical resistance of coals (Sandor)³ has shown possibilities of using this value for control during operational use of coal.

During the past few years some important contributions on radiographic examination of structure, and interpretation of the scattering of X-rays has been made by Prof. H. L. Riley and his colleagues and D. P. Riley in the U.K. and by Mahadevan in India. These papers afford numerous examples of the potential practical application of X-ray investigation in elucidating the structural formation of coals and their behaviour under different circumstances, especially during carbonization. Prof. Riley concludes from his experiments that there is little doubt that many of the important properties of bituminous coals are determined by the ease with which "order-disorder changes, involving the relative movements of large, more or less flat, lamellar molecules, can occur at relatively low temperature. The facility with which these movements can occur under the influence of thermal vibration appears to be determined by the amount of oxygen attached to the lamella. The formation of rigid turbostratic systems is probably connected with the relatively large amount of oxygen which the resultant charts contain. Rigidity in turbostratic systems . . . may be due to the formation of cross linkages between adjacent lamellæ, possibly involving the formation of hydrogen bonds or the steric effect of the relatively large oxygen atom."^{3a} This, for the

first time perhaps, offers a physical explanation of the mechanism of coke formation.

Following Boddy's⁴ demonstration of the plasticity of coal even at ordinary temperatures and under moderate pressures, interesting rheological studies on the flow properties of coal and the relation between the rank constitution and structure of coals and their rheological characteristics, have been carried out (Berkowitz) in the laboratories of the British Coal Utilization Research Association in the U.K. This is completely a new line in the field of coal research, and opens up a very interesting domain for investigations on coal.

An outstanding discovery by Seyler⁵ in the field of petrology of coal is that the "reflectance" or the percentage light reflecting power of coals does not vary continuously with rank, but assumes one or the other of a small number of definite values; in other words, coals consist of optically well defined components, a fact if further substantiated would prove to be of great value in quantitative analysis of components of coal for process control, for example, in hydrogenation.

Much work has been and is being done on the orthodox lines of chemical methods in an attempt to separate and, if possible, to isolate the "units" present in coal substance, but recently a new method of attack was applied by Lahiri, and Lahiri and Mikolajewski⁶ when they successfully attempted to separate the coal bitumen by ultra-chromatographic methods of adsorption analysis.

In an attempt to determine the exact nature of the bituminous compounds present in coal and the constitution of the molecular aggregates present in coal, Sutherland⁷ and his colleagues at Cambridge have applied infra-red spectroscopy, but although some valuable indications of the nature of the radicals present were obtained, results were difficult to interpret due to the extreme complexity of the coal substance. It is thought that a combination of ultra-chromatography and infra-red spectroscopy will go a long way to determine the nature of the soluble components in coal (which according to the modern theorists of coal structure, are the lower polymers of the insoluble coal substance).

Gasification

Most of the work on gasification in the pre-war years was aimed at observation of

changes in gas composition and volume in cycles of blow and run reactions. Thermal data of blow and run reactions in relation to the theoretical heats of reaction were also studied. The purpose was to obtain a greater thermal efficiency. Modern developments in gasification, however, are entirely on new lines⁸ and in most of these methods the reactivity of coke plays a great part. One method involves the use of cheap oxygen and gasification of coal with steam and oxygen under pressure. Another method involves the operation of the steam/oxygen reaction at a high rate to produce a hydrogen rich gas, which in turn is used to gasify coal under pressure. A method which is being investigated is the production of methane by catalysis from mixtures of CO_2 and H_2 (water gas). All these processes call for the physical study of gas reactions under a wide range of conditions.

Other outstanding attempts have been directed towards the production of producer gas from non-coking bituminous coal and in the production of rich hydrogen by alternate reduction and oxidation of ferric oxide by water gas and steam⁹.

In India work was undertaken on a systematic and large scale for the first time, to study the blending of coking and non-coking coals for the production of metallurgical coke. Attempts are also being made to erect a low temperature carbonization plant for effective distillations of coal for by-products recovery and production of domestic coke.

Hydrogenation

Researches on hydrogenation have a bearing on the constitution of coal, since hydrogenation means the breaking down of the coal polymer. It also involves fundamental studies of reaction kinetics and equilibria, the effect and reaction mechanism of the catalysts, effect of variables and application of laboratory findings to large-scale practice.

Since the time of Bergius, great advances have been made in these lines. Literature on the subject is too voluminous to be reviewed here. Most of the work has been directed towards the investigation of the action of hydrogen on various coals and petrological constituents of coal at temperatures varying from 300° C. to 480° C. and at pressures varying from 200 to 250 atmospheres⁹.

The efficiency of a catalyst is judged by the percentage of oil produced on coal by weight. Effect of catalysts like CaO , NiO , Fe_2O_3 , ZnO , $\text{Fe}_2\text{O}_3 + \text{TiO}_2$, GeO_2 and especially $\text{Sn}(\text{OH})_2$ has been investigated as well as the theoretical examination of the function of catalysts and vehicles (Hirst, *et. al.*)¹⁰ has been made.

It was discovered early that during hydrogenation coal becomes partially liquefied and attention was directed both in the United States of America, and in Germany (Pott-Broche process)¹¹ towards the study of solvent extraction of coal¹² in relation to the internal pressure of the solvent. Results suggest that hydrogenation of coal would be facilitated if the initial extracts were stabilized by hydrogen to prevent further polymerization. From hydrogenation of coal, it was logical to expect that the investigation of hydrogenation of the liquid products of coal would follow. King, Cawley and others have investigated the hydrogenation of tar and oils employing the method of continuous flow and using molybdenum disulphide on alumina gel as catalyst. They also devised a semi-technical pilot plant in which work was carried out till 1940 in the *Fuel Research Station, U.K.* Attempts to hydrogenate the tar at two or more stages have also been made.

In India coal research has lagged behind principally due to the lack of a suitable organization for carrying out and co-ordinating such work. A start in the right direction has been made by the *Council of Scientific and Industrial Research* by setting up the *Fuel Research Institute* at Dhanbad near the Bihar coalfields.

References

- ¹ Horton, Randall and Aubery, *Fuel*, 1944, **23**, 65, 100.
- ² Lahiri, *Fuel*, 1945, **24**, No. 3.
- ³ Symposium on *Ultrafine Structure of Coal and Coke*, British Coal Utilization and Research Association Conference, London, 1943. (22 papers.)
- ^{3a} Blaydon, Gibson and Riley, *P. Inst. of Fuel*, Jan., 1945.
- ⁴ Boddy, *Nature*, 1943, **151**, 54; *Fuel*, 1943, **22**, 56.
- ⁵ Seyler, *J. Inst. of Fuel*, 1943, **16**, 134.
- ⁶ Lahiri & Mikolajewski, *Nature*, 1945.
- ⁷ Carmon and Sutherland, *Trans. Faraday Society*, Jan., 1945.
- ⁸ *4th Annual report of the Council of Gas Research Board*, 8, 1944.
- ⁹ *Annual reports, Fuel Research Board, 1935-1939.*
- ¹⁰ Hirst, Eisner, Field, Cooper, Abernethy and Storch: *U. S. Bureau of Mines, Tech. paper*, 646 (1942); Storch, Fisher, Hawk, Eisner, *U. S. Bureau of Mines, Tech. paper* 654 (1943).
- ¹¹ Potte, Broche and others: *Glukauf*, 1933, **69**, 903.
- ¹² Kiebler: *Ind. Eng. Chem. (Ind. Ed.)*, 1940, **32**, 1389.
- ¹³ King and Mathews, *J. of Inst. of Fuel*, 1936, **33**; *Fuel Research Tech. paper*, 40 (1935); King and Cawley, *Fuel Research Tech. paper*, 41 (1935); Cawley and King, *Fuel Research Tech. paper*, 45 (1939) and 51 (1939); King and Shaw, *Trans. Chem. Eng. Congr., of world power conf.*, 1936, **3**, 463; Cawley and Kingman, *Fuel*, 1943, **22**, 156.

APPLIED PHYSICS

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THE fighting forces in the war which has just ended used a tremendous amount of physical equipment, often of a highly complex and sensitive nature. Success in a battle frequently depended upon the superiority of instruments and the accuracy of observation and measurement. Technical weapons and methods were quite early recognized as of far greater importance than numbers of men. Consequently all branches of Physics—mechanics, heat, optics, sound, electricity, magnetism, radio, electronics and nuclear activity—were applied to produce increasingly better and more effective defensive and offensive engines of war, and the belligerent nations spared no effort or expense to undertake huge programmes of research. To speak of only one item of research—generation of nuclear energy—it is known that the U.S.A. alone spent a sum of two thousand million dollars.

While academic research was not entirely neglected, it is understandable that in a war where lives of nations were at stake the most urgent emphasis was laid on the applied side. Physics played an exceedingly important role and Dr. V. Bush, Director of the Office of Scientific Research Development, U.S.A., has mentioned that the call for physicists was the greatest in America, and this may be taken as an index of the position in other countries also.

On looking over the scientific journals for record of investigations on Applied Physics during the past six years, one feels, however, a certain amount of disappointment at the lack of detailed and precise information on many topics of scientific interest which filled the pages of newspapers during the war days. This is not surprising as all precautions had to be taken to keep new devices and appliances closely guarded secrets. The

recruitment to military research services was strictly limited to persons of unquestionable loyalty and as a result leakages do not appear to have been frequent or serious. It is to be hoped that, war being over, information on the many important discoveries made during this period will be available to science at large.

The general results obtained leave no doubt that Applied Physics made great and important progress. Magnetic mine, the Radar, jet-propelled bombers, rocket planes, superfortresses, radio controlled aircraft and last, but not the least, the atomic bomb stand as witness to some of the achievements of the immense efforts made. In what follows we can only have a brief description of some of the items, accounts of which are available.

Nuclear Fission

The phenomenon of nuclear fission was discovered in 1939, just a few months before the war in Europe was declared. Some years previously, the Italian physicist Fermi had conceived the probability of attaching a neutron to heavy nuclei of uranium, protactinium and thorium, and forming elements even heavier than uranium. He appeared to have succeeded in this, but since the half lives of the products were extremely short the identity of the products could not be established unambiguously. Curie and Savitch shortly afterwards obtained a product with a period of 3.5 hours with properties similar to lanthanum. At this stage, Hahn and Strassmann, after a brilliant series of experiments, isolated one of the products, and showed it to be barium. These results were explained by Meitner and Frisch by supposing that the nucleus possessed a latent instability similar to that of a liquid drop and consequently when the neutron collides with the nucleus the latter breaks up into two roughly equal fragments, one of the fragments having atomic number ranging between 50 and 60 and the other from 35 to 42. The release of packing energy in this case has been estimated at 180 MEV which is entirely of a different order of magnitude from the energy released in the previously known nuclear reactions. The change in the atomic structure is cataclysmic and beyond the wildest dreams of the physicists.

The thermal neutrons are most effective for the collision process and it has been shown that of the isotopes of uranium the

one with which the collision is more likely is U^{235} on account of its greater instability. But the proportion of U^{235} in a sample of uranium is only of the order of 1 to 140 and, therefore, any large-scale utilization of the enormous energy available from fission must necessarily be preceded by an easy means of the separation of U^{235} . While no details have so far been published the collection of large quantities of this isotope seems to have been the chief difficulty in the manufacture of the atomic bomb used by the Allies against Japan in the closing phases of the war. Several methods for the separation of isotopes are available and have been discussed by H. C. Urey¹. The thermal diffusion method of Clusius which had been most successful offers many advantages and much promise².

The Cyclotron

The remarkable progress which has been made in nuclear phenomenon would not have been possible without the cyclotron. E. O. Lawrence has now been engaged at Berkeley in the construction of a 184-inch cyclotron, weighing about 5,000 tons, capable of accelerating ions to 100 Mev. It is possible the construction has now been completed but no details are available.

Tracer Technique

The discovery of artificial radioactivity by Curie-Joliot in 1934 and the perfection of the cyclotron by Lawrence producing strong radioactive sources, has led to widespread use of radioactive isotopes as indicators. These radioactive indicators move in company with normal atoms from which they are indistinguishable chemically, and reveal the detailed movements of the normal atoms. Ordinarily there is one tracer atom to every 10^{10} to 10^{15} normal atoms but even with this dilution, the tracer atom is easily detectable on account of its radioactive nature. As an example of the sensitivity of the method, consider the following:

Where chemical methods fail the spectroscope will be able to detect the presence of a minimum of 10^{-7} gm. of sodium comprising

* Since going to press, statements on the atomic bomb have been issued by the Governments of the United Kingdom, U.S.A. and Canada. It is revealed that the transuranic elements, neptunium (93) and plutonium are produced from uranium (U^{238}) by the capture of a neutron, and can easily be separated from uranium by chemical methods. Plutonium undergoes fission like U^{235} and is used in the atomic bomb. Large-scale production of plutonium has been achieved by chain-reactions at a controlled rate.

about 10^{15} atoms. As against this even 10^{-15} or 10^{-16} gm. of radioactive sodium ($^{24}_{11}\text{Na}$) is easily measurable since this amount corresponds to about 100 atoms decaying per second. Thus radiosodium is 10^8 times easier to detect than ordinary sodium. The tracer technique has been widely used in all branches of science, in chemistry, metallurgy, geology, physiology and medicine, and many discoveries have been made which apparently would not have been possible by other known methods.

An interesting case of how nuclear physics has been useful to spectroscopy may be mentioned. Wiens and Alvarey³ have filled discharge tubes with spectroscopically pure mercury isotope of mass 198. Gold has but one isotope of mass 197 which by capturing a neutron forms radioactive gold of mass 198 which decays with a half value period of 2.7 days into Hg^{198} . Such a spectroscopic source has several advantages as lines given out possess no hyperfine structure and no isotopic shift. Also since the mass is heavy Doppler broadening is negligible.

Determination of Nuclear Moments

In recent years Rabi, at Columbia University, has very much improved the technique of measuring molecular and atomic beam deflections in low magnetic fields, where the interaction between the nucleus and the extra-nuclear electronic system is not decoupled, thus enabling the nuclear magnetic moment and hyperfine structure separations to be determined to a high degree of accuracy.

In this molecular beam magnetic resonance method the fine molecular beam passes through two magnetic fields with opposite gradients and becomes focussed on a detector. Between these inhomogeneous fields is a steady field (H) of smaller extent and also a small oscillating field, perpendicular to it. In this region the nuclear moment is decoupled and precesses about the field

direction with Larmor Frequency $\nu = \frac{\mu H}{h}$.

If now the frequency of the oscillatory field, which is of the order of megacycles is adjusted, till it equals ν , the beam is deflected away and is no longer focussed on the detector, and a sharp fall in the beam intensity takes place. This enables μ to be calculated. It is in this way that the magnetic moments of proton, deuteron, etc., have been measured with great precision. Rabi

was awarded Nobel Prize for Physics in 1944.

Induction Accelerator

Repeated acceleration of heavy particles have been accomplished with the help of a cyclotron. Thus protons, deuterons and α -particles have in this way been accelerated to about 100 MEV energy. The essential condition for the operation of the cyclotron is that the time t for completing a semi-circular path is given by $t = \frac{\pi m}{e H}$ and is

independent of the radius of the path and the velocity of the particles. The relativistic change of mass due to velocity is not appreciable. This method is, however, unsuitable for electrons, for in this case, in order to have a moderately high energy, the velocity must be so great that their mass becomes several times the rest mass and, therefore, the time t does not remain constant.

Kerst of the University of Illinois has succeeded in constructing an apparatus on the principle of magnetic induction. Electrons have been accelerated to an energy of 2.3 MEV by the so-called induction accelerator. He has produced electrons upto 5 MEV with even a small model.

The force on an electron of charge e , mass m and moving with a velocity v in a symmetric field H is given by $F = \frac{e v H}{c}$.

This is balanced by the centrifugal force $\frac{m v^2}{r}$. The momentum p of the electron is

thus rHe A change of magnetic flux

enclosed by the electronic orbit produces a tangential force which accelerates the electron, and if the magnetic force is so arranged that p and H increase proportionately, the electron will move in a fixed orbit but with momentum constantly increasing as H increases. In actual practice, a strong varying central field is provided for the necessary flux and a weaker field to hold the electron in its stable circular orbit. After the electrons have been accelerated, they strike a tungsten target, emitting extremely hard X-rays. With a current of one thirtieth of a micro-ampere the intensity corresponds to that of γ rays from one gram of radium.

There are great possibilities for the induction accelerator for producing low energy cosmic rays in the laboratory and for nuclear reactions.

Field Emission X-ray Tube

A new development in radiographic technique is the production of an X-ray tube whereby radiographs of swiftly moving objects can be taken. In principle, the method is simple. A condenser is raised to a high potential and discharged through two cold electrodes, the cathode pointed and the anode flat, kept very close to each other in a high vacuum. This discharge which is almost instantaneous makes it possible to draw several thousand amperes from the condenser enabling a very much larger output of X-radiations, as compared with the usual tubes where only a few milliamperes can be made to pass. Excellent radiographs of bullets in various stages of penetration through obstacles have been taken. The method provides valuable information on the distortion of rapidly moving internal parts of a machine and for all other investigations needing high energy X-rays of great penetrating power concentrated in an extremely short interval of time.

Helium—the Superfluid

The striking properties of liquid He II have been the subject of much important experimental and theoretical investigations. Liquid helium (critical temperature 5.2°K , B.P. 4.22°K) exists in two forms He I and He II above and below the λ -point (2.19°K) respectively. The physical properties undergo remarkable changes as He I is transformed to He II. No heat of transformation is detectable. He I visibly boils like ordinary liquid but immediately the λ -point is passed, the boiling stops and the liquid becomes quiescent. Kapitza has measured the viscosity of He II and finds that it is less than 10^{-9} C.G.S., i.e., at least 10,000 times less than that of the hydrogen gas which is known to possess the smallest viscosity. The electrical conductivity is 1,000 times more than that of copper.

When a temperature gradient is maintained across a volume of He II it behaves as if it consisted of two components moving in opposite directions. The normal He II component carries heat from the hotter to the colder parts and the superfluid He II moves in the opposite direction without any friction.

According to Landau's view⁴, He II is a quantum liquid consisting of two states of potential motion and vortex motion and transition takes place only by a discrete jump,

no continuous transition being possible. The state of potential motion is identified by the superfluid and the state with the vortex motion corresponds to normal He II. Not until the liquid is in the higher vortex state can there be any possibility of dissipation of energy, and the motion of the superfluid is, therefore, thermodynamically reversible since there is no entropy change associated with its passage from one state to the other. The reversibility of the thermodynamic phenomena in He II offers the possibility of developing a method for attaining the absolute zero.

Non-reflecting Glass

It has been known for some time that partial extinction of reflected beam is due to the presence of a film on the surface and the present development is in regard to the investigations of conditions under which this takes place and to the technique for preparing such thin films. When the thickness of the film is of the order of a fraction of wavelength of light, the reflected light suffers in intensity by interference which depends on the refractive index of glass and the wavelength of light. If light is incident normally the reflected beam is extinguished entirely for one particular wavelength, provided the refractive index of the film is equal to the square root of the refractive index of glass and the film thickness is an odd multiple of one-eighth of the wavelength. Several methods for producing such a film are available. The chemical method employs barium stearate or cadmium arachidate suitably treated. The films of magnesium or calcium fluoride produced by evaporation technique have, however, been most successful commercially. The transmission of a single lens increases from 92 to 99 per cent. on coating, so that with eight lenses put in series, the transmission will correspond to 92 per cent. The great advantages of such glasses are obvious and their use is bound to effect the design and construction of optical instruments.

Other Topics

For lack of space we cannot go into even a brief description of many important topics in Applied Physics, but as this note will remain quite incomplete without at least a mention by name of some of these they are given in the following:

1. *Oil diffusion pumps* used for molecular distillation and electronics have reached a

speed of 10,000 litres per second. Octoil and a number of other low pressure oils are available for use and it is possible to attain a vacuum of 10^{-8} mm. of mercury without employing liquid air.

2. A radiation pyrometer described by J. Strong⁵ enables the measurement of low temperatures of distant objects with an accuracy of 1° C. It utilizes the infra-red band at 8.8μ for this purpose, and therefore avoids the absorption due to air.

3. Bridgman working at Harvard University has attained pressures in the neighbourhood of 500,000 atmospheres for determining the properties of substances under such stresses. Carboly bosses were used in these experiments.

4. The last report about the 200 inch telescope at Mt. Palomar indicated that the giant was well on its way to completion. Whether any observations have actually been taken since then is not recorded. The total cost is estimated at 6 million dollars.

5. The electron microscope is rapidly becoming an important tool in all branches of science dealing with the detailed structure of matter. The great resolving power achieved is due to the extremely short wavelength associated with the electron, but the actual value still falls short of the calculated one. V. E. Cosslett has discussed the present position⁶.

Unlike most industrially developed countries, India as an importing country experienced great difficulties in carrying out research work in Applied Physics due to lack of material and measuring instruments. Also most of the research men were absorbed by technical services and in consequence the normal research activities of the universities had to be curtailed. In spite of these handicaps, however, several laboratories with indigenous supply of raw materials or with the help of stocks left over from pre-war years continued their work, and guided by the necessities of the times made useful headway in the development of industrial processes and techniques.

An encouraging factor has been the institution of the *Council of Scientific and Industrial Research* which by a system of grants-in-aid provided considerable encouragement and support to research activity.

Calcutta.—The construction of the 40-inch cyclotron in Prof. M. N. Saha's Laboratory

is nearing completion. B. D. Nag-Choudhri is in charge of the general installation and he is being helped by a number of able assistants. The work was started in 1941 with a gift from the Tatas and the Calcutta University, but the sum proving inadequate, further donations have since been made. The investigations on refrigeration and ultracentrifuge have also been in progress in the University College of Science.

Prof. D. M. Bose has commenced the construction of a large ultrasonic generator with a grant from the *Council of Scientific and Industrial Research*.

Bangalore.—Extremely important work on the structure of diamond has occupied the attention of Sir C. V. Raman. Determinations of the elastic constants of diamond which have also been undertaken to elucidate his new ideas on the nature of diffuse X-ray scattering, will be most useful for the diamond tool industry.

Prof. Raman's contributions to ultrasonics have attracted wide attention and much important work on the subject has emerged from his laboratory.

Trivandrum.—H. P. Waran has had considerable success with optical instruments, a work which he started as Professor of Physics, Presidency College, Madras. It is now possible to produce large astronomical mirrors and interferometer plates to an accuracy of $\frac{1}{10} \lambda$ both in glass and quartz.

Allahabad.—K. S. Krishnan has been working on electrical properties of some typical order-disorder alloys in the neighbourhood of their curie temperatures.

Delhi.—W. M. Vaidya has studied spectroscopically the combustion processes in the internal combustion engine. These investigations which are being continued have already yielded very valuable results.

Lahore.—Electron X-ray tubes for diagnostic work and hot cathode high tension rectifiers have been developed at the Physics Laboratory of the Government College, Lahore.

References

- 1 H. C. Urey, *J. App. Phys.*, 1941, 12, 270.
- 2 A. O. Nier, *Phys. Rev.*, 1940, 57, 30.
- 3 *Phys. Rev.*, 1940, 58, 1005.
- 4 *Phys. Rev.*, 1941, 60, 356.
- 5 *J. Opt. Soc. Am.*, 1939, 29, 520.
- 6 *J. Sci. Instr.*, 1945, 22, 170.

RADIO RESEARCH

By J. N. BHAR

(Radio Research Committee, University
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AS a result of war demand, radio research, both fundamental and applied, made phenomenal progress in the Western countries in recent years. The researches are conducted mainly under the auspices of three different types of institutions:

- (1) Large industrial concerns, which maintain well equipped research laboratories and highly qualified scientific personnel,
- (2) Universities, and
- (3) Government Research Establishments, e.g., Radio Research Boards, Radio Research Sections of the Communication Services, of Defence Services and of the National Laboratories (N. P. L. of England, and N. B. S. of the U.S.A.)

During the war the investigations carried out by all these institutions were organized on a unitary basis. These researches will have far-reaching applications in communication service, broadcasting, in providing safety aids to aerial and sea navigation and in various other services.

Short accounts of principal new developments are given below in their broad outlines. Readers interested in fuller technical details may refer to the articles on "Radio Progress" published annually in the *Proceedings of the Institute of Radio Engineers*.

Broadcasting and Communication

The main development in broadcasting and communication has been the increasing use of frequency modulation—a modulation system perfected mainly through the efforts of Prof. Armstrong in the U.S.A. In the usual system of modulation—the so-called amplitude modulation—the frequency of the carrier wave remains constant while its amplitude is varied in accordance with the sound waves. In frequency modulation, the amplitude is kept constant, while the frequency of the carrier is varied in accordance with the sound wave. Frequency modulation is used with ultra high frequencies (e.g., 45 Mc/sec.). As such, the signals are of short range and are only suitable for local broadcasting and for point-to-point commu-

nication. There are already a number of frequency modulation broadcasting stations working in the U.S.A. Frequency modulation has been extensively employed in army signalling and will find wide application in communication in the Police, Railways and similar other services.

Ionospheric Problems

As a result of war requirements extensive investigations on the ionosphere have been undertaken by establishing additional ionospheric observatories in many of the theatres of war. The data from these stations collected and analysed at a central laboratory give a world picture of the ionosphere—how it varies with the hour of the day and night, with the season of the year, with the solar cycle, and with latitude and longitude. It is now possible with these data to predict the maximum usable frequency (M.U.F.) for maintenance of radio communication between any two points on the surface of the earth.

It may be noted that the ionospheric observations made at Calcutta under the auspices of the *Radio Research Committee* are supplying regular data to a number of central stations for this purpose. Similar observations are also being made at Delhi by the *All India Radio*.

An important subject of investigation has been the relation between ionospheric condition and solar ultra-violet and/or corpuscular radiation. It may be noted that recent solar spectrograms taken at the Mount Wilson Observatory during magnetic storms have for the first time revealed the presence of charged particles speeding towards the earth and causing magnetic storms.

Microwave Technique

The technique of generation and transmission of microwaves (a few centimetres in length) has been highly developed. In addition to the magnetrons, an entirely new type of generator—the Klystron—which was in an experimental stage before the war, has been perfected and is being extensively employed in the defence services for radio-location. Constant research is being carried on in England and in the U.S.A. to produce new types of magnetrons and klystrons of improved performance. The problem of the transmission of the microwaves from the point of generation to that of radiation has led to the development of wave guides. During the war extensive researches have

been carried out on various types of wave guides and on the modes of wave propagation along the same.

Radiolocation—The Radar.—The most spectacular development, vital to the war, utilizing the microwaves, has been the Radiolocator or the Radar. Briefly, the principle is to direct a beam of microwaves towards the object. The waves on hitting the object are scattered just like light and the scattered waves actuate a sensitive receiver on the ground. A specially designed aerial system in conjunction with a cathode ray oscillograph enables the location of the object to be made. The radar principle will find wide application in peace-time for providing safety aids to aerial and sea navigation and also to land transport systems.

Electronics

Extensive investigations are being conducted on the development of various types of electronic tubes, specially for the generation of high power in the ultra high frequency band. The industrial heating of metals by high frequency power has been developed considerably and tubes suitable for this purpose have been produced and are being constantly improved upon. It is estimated that in the U.S.A., the total high frequency power consumed in the industries for heating purposes is far greater than the total power radiated by all the transmitting stations in the country. Dielectric heating has also been developed for application in the manufacture of plywood, laminated plastic sheets and for moulding purposes.

There has also been remarkable progress in the design and production of cathode ray oscillographs. The cathode ray oscillograph is now as common an instrument in the laboratory as an ammeter or a voltmeter.

Application to Meteorology

The propagation of microwaves is markedly affected by the weather condition in the troposphere. Extensive researches are being carried out with a view to study the correlation between the weather conditions and the characteristics of the waves returning from the troposphere. It is now possible to detect clouds by the use of microwaves.

Another application of radio to meteorology has been the location of thunderstorm centres by the measurement of the direction of arrival of atmospherics. Atmospherics

investigations are now being conducted on a world-wide basis. The results of these investigations are of great help in navigation as also in weather forecasts.

In India, in contrast to the Western countries, radio research till recently, was being conducted through the individual efforts of workers in the universities and in institutions like the *Indian Institute of Science, Bangalore*, and the Research Department of the *All India Radio*. The investigations thus carried out covered a wide variety of problems such as ionospheric propagation and characteristics, field strength survey, atmospherics measurements, dielectric properties of soil and ionized gases, acoustic properties of materials, production of radio components, etc. The recent establishment of the *Radio Research Committee* by the *Council of Scientific and Industrial Research* has been a definite step forward in organizing and furthering radio research in this country.

This Committee has recently adopted a programme of research which includes :

- (i) Ionospheric investigations.
- (ii) Study of atmospherics with immediate application to the location of thunderstorm centres.
- (iii) Study of ultra shortwave and microwave propagation and technique.
- (iv) Investigations on the development of circuits, antenna, special apparatus and valves.

At present, investigations on ionospheric problems, direction of arrival of atmospherics and on the production of radio components are being conducted.

SCIENTIFIC INSTRUMENTS

By I. RAMAKRISHNA RAO

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IN the latest global war, scientific instruments have played a role of far greater importance than in any other conflict since the dawn of history. Economy, precision, compactness and multiplicity in application were the primary considerations in their design. At the present juncture, it is possible only to conjecture the probable instruments invented, as each nation involved in the war is yet to reveal these innovations. Mechanical, optical, acoustical and electrical instruments have contributed immensely to the early termination of the war.

The laurels must be given to electronics which demonstrated beyond doubt their universal utility in all aspects and stages of war. From communications on the one hand, to plane location and direction finding on the other, the radio instruments have rendered immense service both in offensive and defensive warfare. The radar saved millions of British lives by helping in locating enemy planes during the *blitz* on London. Radio signalling miniature balloons for automatic transmission of conditions of temperature, pressure and humidity of the upper atmosphere have facilitated safe aviation, which was the principal mode of transport during the war. Pocket transmitters and receivers have become commonplace and almost every soldier in ten was equipped with these devices. In war-time feeder laboratories at home, the electron tube has helped in military scientific research to a remarkable degree. Automatic recording instruments have been used by the millions in all war-production industries for testing, measurement and control.

The infra-red camera, which was in the experimental stage previous to the war, was perfected and it helped in eliciting information from enemy countries at night through reconnoitring planes. We read, in Journals of scientific instruments, of improved types of infra-red spectrographs. Mechanical, thermal and optical instruments of different kinds must have been improved and invented in the race against time for winning the war.

Progress in instruments for pure research too was not slow during this period. The electron microscope is now perfected and made as simple in operation as an ordinary microscope. The spectrograph is improved and altered to keep pace with its increasing application in science and industry. Instruments for research in radio-activity and nuclear physics are to play a unique role in the near future with the latest revolutionary discovery of atomic energy, which has opened immense possibilities of industrial power production and which may be the harbinger of a new civilization altogether.

Before 1939, India was importing almost all scientific instruments. But war has brought about the necessity of manufacturing certain instruments for civilian use by the few concerns dealing with them. These are simple measuring instruments like balances, vernier microscopes, volume and pressure

gauges, etc., of an elementary nature. Even these do not seem to be subjected to proper test and standardization. Automatic recording and controlling instruments are yet a novelty in this country. Precision in instrument manufacture is still to be initiated. Research in this direction is unknown. In spite of the great spurt in research activities both in Government and university research laboratories, very little attention has been given to the development of the instruments, which are the tools of research. Out of the score of universities in India, only two have departments of Applied Physics dealing with the subject of scientific instruments. Out of the 90 research schemes either newly granted or renewed this year by the *Council of Scientific and Industrial Research*, there is only one bearing on the manufacture of electrical measuring instruments.

The basis of all scientific and industrial progress is measurement and this is done by instruments. Unless a country is self-sufficient in its scientific instrument manufacture, this progress is sure to be retarded. The starting of a National Physical Laboratory at Delhi is a welcome move. Its inauguration will greatly help the testing and standardizing of scientific instruments. The immediate need is to stimulate research and manufacture of instruments. Scientists and industrialists should sponsor and encourage universities and manufacturing concerns to take up researches in the design and manufacture of scientific instruments. The Bengal Research Board is reported to have taken on hand researches on the design and manufacture of measuring instruments.

Yet another important handicap experienced by persons directly connected with instrument manufacture is the paucity of certain basic materials in India required for manufacture. As examples may be mentioned, lack of high grade steels, magnetic materials, optical glass, steel and non-magnetic springs, ball bearings, high grade metals for other types of bearings, jewel bearings, non-expansion alloy steels, electrical resistance alloys, etc., all of which are important. Fundamental applied research for production of these and similar items must be started immediately. The country is not lacking in either technical skill or scientific intelligence for tackling all the problems connected with the development of the industry.

STATISTICS, STANDARDIZATION AND QUALITY

By HARI KINKAR NANDI

(Statistical Laboratory, Calcutta)

THE pioneering efforts of Dr. W. A. Shewhart of the *Bell Telephone Company*, New York, during the twenties had shown how the technical knowledge of a production process aided by methods of statistical analysis can raise the standard of economic efficiency. The point can be illustrated by considering the manufacture of an article of common use—the metallic filament of an electric lamp. At a given efficiency of light emission the quality of this article is measured by the length of its life. This quality varies from lamp to lamp, due to various causes, of which the important ones are (1) the quality of the metal, (2) the uniformity of the diameter of the wire, and (3) changes in treatment due to coiling, exhaust and gas-filling the lamp, etc. Variations in (1) the quality of metal, can be controlled by adequate testing at the time of purchasing the raw material. Variations in (2) and (3) must, however, be controlled during the actual process of manufacture. To do this effectively, the only possible method is to set up an efficient system of testing. Even when the production has been brought under control, constant vigilance is necessary to maintain it. The producer must, therefore, test a suitable number of lamps as they are manufactured, and see whether their performances are up to specifications. How many lamps to test, how to choose these lamps, and how to judge the quality of the whole batch from the test results of the samples—these are the fundamental problems which can be solved only with the help of appropriate statistical methods.

Standardization means setting up of standards of quality and methods of testing to ensure conformity to them. This is as important to the producer to save him from unnecessary rejections, as to the consumer to guard him against accepting goods of inferior quality. Standardization is even more imperative in order to enable mass production methods to come in general use so that parts manufactured separately can be assembled without difficulty.

Much progress has been already made in Western countries not only in evolving suitable statistical methods but also in

applying them in practice for the detection of major causes of variation in the quality of goods by installing appropriate inspecting programmes in which a small number of articles are selected in a suitable manner out of a lot and tested in order to assess the quality of the whole batch of goods in the lot, and by specifying a routine analysis to detect lack of control by the use of what are called "control charts." The performance of test pieces are plotted on these charts on which upper and lower limits are shown by drawing horizontal lines in a prominent manner. If a test result falls outside these "control limits," it is interpreted to indicate lack of control and is used as a kind of *red signal* or warning demanding further investigations. In major industries in the West, expert statisticians are always appointed to look after this kind of work.

For standardization many institutions have also sprung up which work in close collaboration with statistical institutes, for example, the *British Standards Institution* and the *National Physical Laboratory* in Great Britain, and the *National Bureau of Standards* and the *American Society for Testing Materials in U.S.A.* Many books and pamphlets on the application of statistics to industry have been published in recent years, among which mention may be made of the publications of the American and the British Standards Associations.

In India, very little attention has been paid so far to "standardization" and "quality control." Most industries have no statisticians on their staff to study conditions and efficiency of production, nor is there any institution like those in the U.K. and U.S.A. The *Government Test House* at Alipore, it is true, has done a certain amount of work in the preparation of specifications for quality standards and in testing articles in conformity to such specifications. These standards and specifications, however, still lack an adequate statistical basis. Some of the specifications which have been copied from Western countries do not give satisfactory results, but no systematic attempts have been made so far to investigate the causes of failure or to set up modified specifications to suit local conditions.

It is a matter for congratulation that the Government of India have now realized the need of standardization and are beginning to take necessary action in this matter. The proposal for starting a *National Physical*

Laboratory on the lines of the institution at Teddington is very welcome. The setting up of a *Statistics Committee* on Standardization and Quality Control by the *Council of Scientific and Industrial Research* is also a step forward in the right direction. This *Committee* have already made arrangements for giving training in statistics to a batch of students who are already employed in industry; and training classes were started in August 1945 in the *Indian Statistical Institute, Calcutta*, for this purpose. It is hoped that this *Committee* consisting of both industrialists and statistical experts under the chairmanship of Professor P. C. Mahalanobis, would gradually take other steps to help Indian industries to utilize to the best advantage modern statistical methods for the all-round development of the country in the post-war period.

BUILDING MATERIALS

By V. G. GARDE

(Thomason College, Roorkee)

Soil Cement

THIS material has been developed in the U.S.A. primarily for cheap roads carrying light pneumatic-tyred traffic. This type of road is made by predetermining by scientific tests the amount of cement, moisture and density which from a particular soil would produce a road capable of withstanding the effects of wetting and drying, and freezing and thawing. Proper hydration of cement, as also good field control are very important for attaining this end.

The laboratory tests as well as the construction methods are quite simple. The following are the important points with regard to the construction of this type of road:

- (i) The existing earth or gravel road is scarified to a depth of about 6".
- (ii) The scarified material is pulverized with offset disc harrows or other suitable equipment.
- (iii) A predetermined amount of cement is spread in a uniform layer over the surface.
- (iv) The cement and pulverized earth are thoroughly mixed with disc harrows.
- (v) The predetermined amount of water is added with a pressure distributor and mixed with the mixture of soil and cement, disc harrows being used for this operation also.

- (vi) The mixture is now consolidated to the required density by means of a sheeps foot roller.
- (vii) A blade grader is now used to shape the road to the required crown and camber.
- (viii) The top surface is then scratched with a spike-tooth harrow.
- (ix) Finally, the road is ironed out with a smooth-wheel tandem roller. Before throwing the road open to traffic it is cured for a week or ten days.

Other uses of Soil Cement Mixtures.—In addition to roads for light pneumatic-tyred traffic, soil cement mixtures are used in the U.S.A. for the following:

- Runways at less important airports.
- Areas between concrete runways at important airports.
- Residential streets.
- Hardening ground to reduce mud and dust nuisance.
- Linings of stormwater drains.
- Earthen dam cores, facings, etc.

Lightcrete

This material is precast cement concrete in which, instead of stone, woodwool is used as an aggregate. As woodwool is perishable it is rendered more or less inert by a patent process.

In "Feathercrete" rice husk is used instead of woodwool as aggregate. Since this material contains silicon, it is claimed to be almost imperishable. The natural air pockets of rice husk impart good heat insulating properties.

"Thermo-Litecrete" is slightly more expensive than "Feathercrete." It is, however, better than "Lightcrete" and "Feathercrete" in the following respects:

- (1) In the case of both Lightcrete and Feathercrete, unless special precautions are taken, plaster applied to their surface cracks. This does not happen in the case of Thermo Litecrete because in this, lightweight concrete is encased between two thin coatings of ordinary sand and cement concrete, with the result that plaster applied on it behaves in a manner similar to that on ordinary concrete or brickwork.
- (2) The two thin coatings of ordinary sand and cement concrete protect the lightweight concrete which they encase.

The above three materials are manufactured in the form of slabs, and hollow or

solid blocks. They can be sawn, nailed or drilled. On account of their low conductivity of heat and sound and light weight, they can be successfully employed in the construction of partitions, floors and ceilings. In roofs they have not proved a success as they are not sufficiently impermeable.

Pre-fabricated Bituminised Surfacing—P.B.S.

This material is made by impregnating jute sacking with bitumen. The procedure of manufacture is as follows:—

- (i) Low Melting Point (L.M.P.) and High Melting Point (H.M.P.) bitumen is heated in melting tanks to a temperature of 300° F. and 350° F. respectively, and is fed through pipes into impregnation tanks.
- (ii) Jute sacking which forms the foundation to P.B.S. is first dried over steam-heated drying cylinders immediately before its immersion in L.M.P. bitumen.
- (iii) The dried sacking is then impregnated with L.M.P. bitumen and then coated with H.M.P. bitumen, after which it is passed through a water tank for cooling. After cooling it is dried by brushes, and cut into pieces 35 yards long.
- (iv) Anti-tack dusting in the form of fine wood flower is applied as the sheet is rolled on the winding machine.
- (v) Finally, P.B.S. rolls are sealed with an application of H.M.P. bitumen wrapped in a cover of sacking to prevent them sticking to each other in transit and store.

P.B.S. is essentially a waterproofing material and is used in the construction of roads and airfields. P.B.S. converts a fair-weather road or airfield into an all-weather one. It has also been used for making roofs watertight. During the war, due to shortage of corrugated galvanized iron and asbestos cement sheets, sheds were roofed with wooden planks on which P.B.S. was laid. This provided a thoroughly satisfactory roof.

MOBILE PRODUCER-GAS PLANTS

By H. B. DUNNICLIFF

(War Transport Department, New Delhi)

DURING the past two years, increasing attention has been paid to the scientific development of producer-gas transport and to the design, manufacture and testing¹⁻⁴ of mobile producer-gas plants for this purpose.

The Producer-Gas Conference which met in New Delhi in October, 1944, has been briefly noticed in current literature^{5, 6} but the perusal of the full report⁷ is recommended to those who wish to have a comprehensive survey of this subject as it has been developed in India. One of the most important decisions was to form a Standing Producer-Gas Research and Development Committee comprising the officers in charge of the testing stations at Delhi (Master Station), Bombay, Calcutta, Madras, Nagpur and Trivandrum. All-India standards for bench and road trials were decided and subsequently accepted by the Provinces and States. The improved performance and diminishing complaints heard in the past years have been largely due to the greater attention to sound manufacture, competent fitting and improved operation resulting from the personal efforts of the technical officers and inspectors in the Provinces who have given increasing attention to road trials and other practical tests in solving owners' difficulties either in demonstration vehicles or using the lorry or bus with which difficulty had been experienced. To their efforts must be ascribed a large measure of the success which has been achieved in increasing the volume of producer-gas transport. On 30th November 1945, the total number of conversions stood at 24,103 vehicles of which 22,725 were transport vehicles, i.e., buses and trucks. Of these 24,103 vehicles, 21,497 including 20,283 buses and goods vehicles were still in service representing about 40 per cent. of the total number of civil vehicles in these classes on the road in India—a notable achievement.

During 1944 and 1945, 26 new model plants (12 down-draught, 6 up-draught and 8 cross-draught) passed the prescribed road and bench tests⁸, and were approved for fitment to controlled vehicles by Provincial authorities. No very noteworthy departures from the three well-known types were recorded. In all, 57 different approved models have been constructed in India. Of these, 15 have now ceased production and 16 have not yet been placed on the market. In addition to these, there are five well established bus companies in South India who manufacture their own design approved plants for use in their fleets.

Fleet-owners and those who administer producer-gas transport have appreciated a pamphlet⁹ published by the War Transport

Department in June 1945, which should be read in conjunction with the Conference Report⁷.

The proposal for opening Provincial Driving Schools has not achieved the measure of success desired but the Bombay Government has extended its efficient teaching facilities in this field to trainees from other Provinces and Indian States.

There have been marked improvements in the organization of regular supplies of better quality charcoal and a number of new varieties have been tested chemically and on the road. The staff of the *Council of Scientific and Industrial Research* have shown that the snow-white high lime content ash frequently found in the generators, is probably due to failure to strip the bark from wood billets before carbonization. As already emphasized in the Australian Standard Specifications, bark should be removed when preparing wood for the manufacture of charcoal for mobile producer-gas plants. The Research Department at Trivandrum¹⁰ has arranged to supply a high grade charcoal for producer-gas investigations at the six testing stations so that research work may be carried out using a standard fuel. No material progress has been made in briquetting charcoal dust or charcoal *cum* coke dust for producer-gas plants.

Shortage in supply of charcoal, the only fuel so far used in mobile producer-gas plants in India, has stimulated interest in the possible use of other cheap fuels such as grain husks, raw wood or solid mineral fuels.

So far, no plant is being marketed in India which burns wood, but Mr. B. Sengupto of Bombay has devised a down-draught plant which is capable of using wood chips, and further developments in its use are expected. The latest standard design wood-operated producer-gas plant for driving tractors in Russia has recently been reported¹¹. While India possesses no indigenous anthracite, Dr. C. Forrester of the Indian School of Mines, has expressed the view that certain coals in Assam and the Punjab may be usable in a double hearth type of plant designed by a New Zealand inventor who has kindly placed a car model at the disposal of the Government of India for experimental purposes and investigation work is proceeding at Dhanbad.

A British Emergency Producer, designed for anthracite or activated coke and used as a trailer plant in England, was submitted to road trials by Mr. C. W. Cassé of Cawnpore and to bench tests by Dr. L. C. Verman in Delhi, using Indian charcoal as fuel. The road trials were fairly satisfactory, but Dr. Verman reported that the gas filtration arrangements, even when modified for charcoal fuel, were not adequate to cleanse the gas from dust to the standard prescribed for mobile producer-gas plants in India, a result which was borne out by the cylinder wear suffered by the engine used.

Although it is commonly stated that producer-gas in an unaltered petrol engine gives about 60 per cent. of the power of petrol in the same engine, numerous power tests both by bench and road trials under Indian conditions have shown that the power ratios ordinarily to be expected from well-designed plants using charcoal fuel average for an up-draught plant, 0.50 to 0.48; for a cross-draught plant, 0.45 and for a down-draught plant, 0.43.

The production of rectified spirit (96 per cent. alcohol by volume) as a motor fuel in the United Provinces has enabled Dr. Verman and his colleagues to examine the use of alcohol and producer-gas as a mixed fuel. Goldman and Clarke Jones¹² stated that, with a compression ratio of about 6, found in a number of commercial vehicles, the same horse-power output can be obtained from an engine running on producer-gas with alcohol injection as can be obtained when the same engine is running on straight petrol. The richer fuel gas mixture assisted in the volumetric sense by the high latent heat of vaporization of alcohol is responsible for this result. A series of preliminary bench tests carried out without altering the jet or carburettor float, showed that, at 2,000 r.p.m., an increase of b.h.p. by 80 per cent. on that given when running on straight producer-gas could be achieved with an expenditure of only about 50 per cent. of the spirit consumed if the alcohol was being used neat. The b.h.p. of the straight rectified spirit used in these experiments was about equal to that using producer-gas. As determined by the composition of the exhaust gases, the combustion was rather more complete with the mixture than with either component separately, but it gave a somewhat higher though not dangerous acid value.

Trials on the road are now in progress and further experiments are projected.

Dr. E. Spencer of Calcutta patented a device¹³ by the use of which it was claimed that up to 20 per cent. exhaust gases supplied to the generator resulted in a considerable saving of fuel without loss of power. A number of road trials using this invention have shown that at any concentration there is a loss of power. For example, in one case at 29 m.p.h., using 4.5 c.ft. per minute of exhaust gases (about 4 to 5 per cent. of the fuel-gas mixture) showed a saving in fuel of 6.5 per cent., at the expense of a power loss of 12.5 per cent. It is possible that with a plant other than that actually used for the experiments (Simpson M.P. 1), more favourable results might be achieved. Further trials will be made using a different model gas-plant, e.g., a type containing a fire-brick lining.

The late Major D. J. Dalgarno's patent¹⁴ designed to conserve fuel without loss of power by utilizing the heat from the generator to pre-heat the air going into it, was modified and tested by road trials using a 3-ton Chevrolet truck carrying a load of 3.5 tons above chassis weight. The air was heated by a multiple pipe heat-interchange placed in the first cooler. The producer-gas petrol/power ratio on the bench was 0.5 but, as measured by hill climbing and acceleration tests, though still within the prescribed limits, it was somewhat lower with the pre-heater fitted. The charcoal saved was 13.5 per cent. and it might be profitable to try this device out on a commercial scale.

Investigations on the addition of water, either as vapour or by injection, have been reported from Delhi and Bombay. At the former station, the tests show unfavourable results using up to 27 per cent. of water on the weight of charcoal consumed but Mr. Sengupto reports very considerable fuel saving in his experiments at Bombay. The two laboratories are in correspondence and it is hoped that on this, as on the other investigations mentioned, a full report will be issued in due course.

One of the decisions at the Producer-Gas Conference was that a standard mobile producer-gas plant should be developed. Messrs. Salter and Deshpande of Trivandrum have proposed a design for a down-draught plant, which is generally agreed to be the most desirable type in a country where

provision must be made for the use of charcoal of such variable standards. Their proposals are under consideration by the Producer-Gas Standing Research Committee. Water injection would be precluded and the cooling and filtration systems will be settled in discussion. A standard filter cloth¹⁵ has been proposed and workers at several stations are investigating the question of the standardized packing of various filtration units with materials such as coir, sisal, cotton waste, etc.

The staff of the *Council of Scientific and Industrial Research* have recently applied for a patent for a wet cyclone filter which is now about to undergo practical trials on the road.

Whilst it is felt by many that the cessation of hostilities will probably mean the reversion of a great proportion of existing producer-gas transport to petrol, it is hoped that the advances which have been made under the stress of war will give this alternative fuel a longer lease of life. Even if it is not used for motor vehicles, there seems to be a field for the development of producer-gas as a fuel for small stationary units conveyed from place to place on trailers and which can be used as water pumping machines in connection with agriculture or as power units for small-scale industries where large supplies of power are not easily available.

References

- 1 Verman, L. C., *J. Sci. Ind. Res.*, 1944, 2, 251.
- 2 Verman, L. C., and others, *J. Sci. Ind. Res.*, 1944, 2, 203.
- 3 Dunncliff, H. B., *Indian Information*, 1944, 14, No. 129, p. 70; *ibid.* 15, No. 148, pp. 459, 464.
- 4 Verman, L. C. and Nair, K. A., *J. Sci. Ind. Res.*, 1944, 3, 452.
- 5 Dunncliff, H. B., *J. Sci. Ind. Res.*, 1944, 3, 268.
- 6 *Curr. Sci.*, 1944, 13, 271.
- 7 *Report on the Conference of Producer-Gas Technical & Testing Officers*, Oct. 12-14, 1944, Government of India Press, New Delhi, 1945.
- 8 *Vide* (7) pp. 5-9; *ibid.* Appendices 1 and 2.
- 9 *The Organization of Producer Gas Transport in India*, Government of India Press, Simla, 1945.
- 10 *University of Travancore, Council of Research, Report*, June, 1945, pp. 4, 5. See also Ref. 7 pp. 9-11; 29-40.
- 11 *Gas and Oil Power*, 1945, March, 40, 87 and 89-95.
- 12 Goldman, B., and Clarke-Jones, N., *J. Inst. Fuel*, 1939, p. 124.
- 13 *Indian Patent* No. 29272, (1945).
- 14 *Indian Patent* No. 27499, (1940).
- 15 Verman, L. C. and others, *J. Sci. Ind. Res.*, 1944, 3, 251.

REVIEWS

The Power Behind Their Wings—(An account of the part played by Sir Henry Royce and the Rolls-Royce engines in the development of the in-line liquid cooled aero-engine). 1945. Pp. 68.

THE book gives a very interesting account of the development of the famous Rolls Royce Aero-Engines, and depicts a very graphic picture of the efforts of Sir Henry Royce who created them. In my opinion the human side of great men like Henry Royce, is not only interesting to read but is a source of inspiration to many men who have great ideals before them. Here, in the story of their life, you have an opportunity to see into the working of their mind, their keen and alert brain and above all, a very rigid self-discipline. The little book gives, while describing the merits and achievements of the famous Merlin Engines, the life history of Sir Henry Royce with sufficient detail to give the reader a glimpse into his personality.

The first two chapters give an idea of the early history and the development of the "Eagle." The third chapter is the most important from the point of view of engineers. Here one can get an idea of the technical ability and scientific acumen of the great man. No wonder the Directors of the Company printed the memoranda and letters written by H. Royce and made them available to engineers in the Rolls-Royce works. In the words of the author, "A reading of this work is as though an art student could still look over the shoulder of a Rembrandt as he wields his brushes, or the young scientist could still assist at the experiment of a Faraday."

A good deal of information about the development of alloys, the difficulties in the development of the higher power engines, the rigid inspection and methods of production and the experimental methods of testing the performance and strength of the engines, is given in this little book without burdening the reader with technical details. The photographs at the end of the book give a picture of some of the production methods. The quotation from Sir Henry Royce—"There is no sure way of judging

anything except by experiment" gives an apt finishing touch to the book. In short, one gets the impression, and very correctly so, that the power behind their wings is not so much the "Merlin" as the great personality of Sir Henry Royce.

V. M. GHATAGE.

Waveform Analysis. By R. G. MANLEY. (Chapman and Hall Ltd., London) 1945. Pp. xi+275. Price 21s. net.

Analysis of vibrations is one of the most important problems in modern engineering practice. Use of higher speeds and use of larger sizes of machines and machine parts, has made this problem still more important and the full understanding of the theory and applications of vibrations is not merely a matter of special interest, but is an essential prerequisite for every student of mechanical and structural engineering. The theory of vibration problems has been dealt with in a number of well written books such as *Vibration Problems in Engineering* by Timoshenko. Books that give collected information on the subject, and the interpretation of experimental data and records obtained from large numbers of elaborate tests, in addition to the theoretical basis of the problem, are few and Mr. Manley's book is a distinct contribution to the engineering literature.

The book, as the author claims, is a guide to the interpretation of periodic waves, including vibration records, and as such includes a good deal of harmonic analysis dealt with in a number of books treating the subject from different points of view. However, the author has done well in including information such as the Fourier Series and its mathematical analysis, as the reader will be saved the trouble of referring to other books for such information. The chapter on "Envelope Method" forms the most important part of the book, and in my opinion, the most useful one to the student engineer for interpreting the results of vibration experiments, especially when the problem in question is of a complex nature and its mathematical analysis very laborious, if not impossible.

It is important in the interpretation of vibration records to develop a sense for recognizing the wave components of known types in a complex record. The method of synthesis where known simple wave forms are combined together in different ways to get a complex curve, helps in developing this sense and the two chapters, one on the Method of Superposition and the other on Numerical Methods, give valuable guidance to the student in this method. The chapter, "Practical Requirements for Waveforms," is an example to show how the author has placed the requirements of the engineer in the forefront while preparing the book. The matter included in the appendix is very useful and, I believe, it will be consulted often by the student and professional engineer alike. Answers to exercises are provided and a good bibliography is included at the end. In short, the book rightly justifies the claims it makes, and it should find a place on the book-shelf of every engineer.

V. M. GHATGE.

The Indian Sugar Industry (1944 Annual).

Editor: MR. M. P. GANDHI. (Gandhi & Co., Bombay) 1945. Pp. xxxvi+90+30. Price Rs. 6-8.

The latest "Annual" has kept up its reputation as a comprehensive review of one of India's biggest industries. Like its forerunners, the 1944 Annual also abounds in well arranged statistical data and tables. A critical review of all the Government measures on the industry is given. The features of the year 1944 are placed in an impressive setting of the progress made by the industry during the past years and also of the world sugar position. The prospects of the industry in the near future, the problems facing it and the Editor's own views of their solution, are of great value to technical as well as business men in the industry.

The world sugar output has suddenly fallen from 30 million tons to about 19 million tons. Viewed in this light, the importance of keeping up the maximum output of the Indian sugar industry cannot be overstressed. The number of sugar factories in India working during 1944 was 144, as against 151 in the previous year. Therefore, maximum production of cane

and efficiency of manufacture are the only ways of increasing the output. From this point of view, the discussion by the author of the various problems connected with the development of the industry is quite illuminating.

Considerable information on the power and fuel alcohol industry is given. There has been a rapid growth of this by-product industry in the U.P., and it is appropriate that this development should be adequately reviewed.

There are 35 instructive tables giving statistical data. The texts of the Control Acts are given. The book ends with a comprehensive list of the Indian sugar factories.

The "Annual" is recommended for one and all interested in the sugar industry.

G. G. R.

Spectrophotometry in Medicine. By PRIV. DOZ. DR. LUDWIG HEILMEYER. (Adam Hilger Ltd., London) 1943. Pp. xiv+280. Price 30s. net.

With the progress of research in applied physiology and clinical medicine, the importance of pigments in the metabolic processes of the cells is being increasingly recognized. Research in this field, however, has been handicapped to some extent owing to lack of information, in the English language, on the methods and technique of quantitative measurements. The book "Spectrophotometry" supplies this want to the workers. This publication is, therefore, to be welcomed.

The usefulness of the book will be greatly enhanced by including within its scope vitamins and cellular enzymes. It would also be useful to add at the end of each chapter (or at the end of the book as a supplement), precise practical directions for both qualitative and quantitative tests on substances dealt with in the book.

The book represents a noteworthy and successful attempt to bring together valuable information relating to the application of spectrophotometry to medical research. It should prove to be of immense value to all research workers who will find the information accurate and to the point.

S. N. MATHUR.

Reports from States and Provinces

Travancore

Council of Research

THE fifteenth meeting of the *Travancore Council of Research* was held on Wednesday the 10th October 1945 in the University Buildings with *Sachivottama* Sir C. P. Ramaswamy Aiyar in the chair.

The Vice-Chairman of the Council, Dr. K. L. Moudgill reported, among other matters, that Government had sanctioned the starting of a model salt factory at Thattarippu Odai Allom, for the production of common salt by the University Method and the processing of by-products of the salt industry. In respect of pyrethrum, the cultivation and collection of flowers has been entrusted to the Forest Department, the preparation of the extract to the Department of Research and the field spraying to the Department of Public Health. The production is expected to reach 20,000 gallons in the course of 12 months.

It was reported that 72 local tapioca varieties had been registered and were being cultivated in the Tapioca Farm near the Guest House, together with four new varieties evolved. More than 1,000 cross-bred varieties have been obtained during investigations in the Department of Research.

Two samples of Derris root grown in Travancore by Mr. Kurien John had given a Rotenone content of about 3.8 per cent. which is quite promising.

Mr. K. Velayudhan Pillai, Junior Bacteriologist, gave an account of the experimental production in the Public Health Laboratory of unconcentrated Penicillin on a limited scale. Satisfactory results have been obtained with this material in the General Hospital.

The following resolutions were passed:—

Live plant collections of tapioca and plantains be maintained in the *Tapioca Farm* under the Department of Research, and of paddy and pepper in the farms attached to the Department of Agriculture.

A Biological Control Station be established for the pest *Teorya purchasi*, in addition to the quarantine station proposed to be established by the Department of Agriculture.

Mr. M. P. G. Nair, Principal of the *Institute of Textile Technology*, exhibited samples of non-crease cotton fabrics and waterproof umbrella-cloth prepared in the *Institute*.

Travancore and Cochin

Mr. G. Parameshwaran Pillai, Reconstruction Officer, Government of Travancore, dealt with the reconstruction schemes of Travancore and Cochin in a talk broadcast from the Delhi Station of *All India Radio*, on 17th Nov. 1945. Mr. Pillai stated that revitalization of agriculture with a view to augmenting the food resources of the States was the foremost aim of Travancore and Cochin. Notwithstanding the programme to increase the area under cultivation by reclamation of backwaters and by throwing open for cultivation suitable lands out of the reserve forests in Travancore and Cochin States, no tangible results can be achieved without the introduction of intensive and improved methods of production and the extension of irrigational facilities.

The *Travancore Fertilisers and Chemicals*, started with a capital of three crores of Rupees, is making rapid progress. Plant and machinery for the production of fifty thousand tons of ammonium sulphate are being installed.

A sum of nearly one crore of rupees has been set apart by the Travancore Government for the construction of the Perunchani Reservoir and for raising the level of the Kodayar Reservoir and for the restoration and improvement of major irrigation tanks. Estimates are being prepared also for other major irrigation works such as the Neyyar Scheme and the combined irrigation and hydro-electric scheme known as the Pambayar Scheme. The Cochin Government have undertaken the investigation of major irrigation works such as the Chalakudi River Diversion Scheme, the Naduthodu, Peechi and Pillathodu Schemes, besides two important drainage schemes.

The Travancore Government have already initiated a five-year programme of development of the Pallivasal Hydro-electric Project costing over rupees three crores. The Travancore Project now supplies electricity to Cochin. The Cochin State has decided upon a programme of development of its power resources at Poringalkuthu.

Over eighty per cent. of the total production of rubber in India is from Travancore, and the Travancore Government are interested in establishing a factory for the manufacture of motor tyres. There is already a rubber factory working in the State, which was operating for war purposes. The production will now be turned over for civilian use.

A cement factory to meet the demands of Travancore and adjoining areas will soon be established and steps are being taken to develop the Ceramic Factory on a cottage industry basis.

The natural resources, abundant in Travancore for the starting of a rayon factory, are being exploited and it is hoped that the establishment of a rayon factory in North Travancore will soon be an accomplished fact.

The existing plywood factory and glass factory are being developed.

Geological Survey

A geological survey of Travancore and Cochin forms a prominent item of the reconstruction schemes of Travancore and Cochin States. The Government of Cochin have started an Industrial Development Fund for giving financial help to industrial undertakings. Prominent amongst the industries sought to be developed in Cochin are those based on forest and fishery resources, sugar, cotton textile, rope, paints and glass.

The aim of Cochin State is to provide road communication so that every village group can be brought at least within half a mile from a main public road. The road development programme of Travancore State, in addition to connecting villages with the main centres of trade, will also be co-ordinated with the traffic routes along canals and internal waterways.

Mysore

Board of Scientific and Industrial Research

At the fifth meeting held in the Indian Institute of Science, Bangalore, on 5th November 1945, with Sir J. C. Ghosh as Chairman, the *Board* resolved unanimously that the time was opportune for starting a Central Industrial Research Institute in the State with good equipment and expert personnel. A sub-committee with Sir J. C. Ghosh as Chairman was constituted to work out the details and give a definite scheme for being forwarded to the Government.

ERADICATION OF PRICKLY-PEAR

By GEORGE MULGRUE, *Sydney*

NO one really knows who first brought the prickly-pear to Australia. There is a story that Governor Arthur Phillip did it to provide food for the cochineal insect, so that he could have dye for his soldiers' coats. But that probably isn't true. What is much more likely is that someone thought that cactus plants would be nice as ornaments in the garden.

There came a time when it seemed that the plant would take over the whole country. It was not the originally imported plants that did the damage. No one heard much of the prickly-pear till farmers began about 1860 to use it for hedges and as cattle food. By 1900 it was becoming a real menace. People began to realize that something must be done. The only trouble was that no one knew what. To attack the pest with mechanical and chemical methods would cost about Rs. 85 an acre, and as the land was only valued at between Rs. 2-12 and Rs. 16 an acre, this was obviously uneconomic. A search began for some other way to fight the pest.

In the meantime, the prickly-pear was really getting under way, and by 1925 had taken over an area 1,000 miles long in Queensland and New South Wales almost as far south as Sydney. The pear occupied an area of more than 60,000,000 acres, which included some of the best country—a belt that began about 50 miles from the coast and extended up to 300 miles inland. The rainfall of these parts was from 20 to 30 inches, and it contained land suitable for sheep and cattle grazing, dairying, and the growing of maize, wheat and cotton. Some of this country was as yet unoccupied, but much of it had already been settled and the settlers were fighting a losing battle against the invasion. They tried ploughing the pest, crushing it and a hundred other

things, but they were mostly hampered in these mechanical methods by the heavily timbered nature of a great deal of the country. In the end, poisoning, usually with arsenic in some form, was found to be the only method possible, but this too was far too expensive, and gradually more and more of them gave up the struggle and abandoned their farms.

There seemed to be no remedy, and in 1924 the *Queensland Prickly-Pear Commission* announced that the task of clearing was impossible and that even if it weren't the cost for the first clearing alone would be in the neighbourhood of Rs. 85,60,00,000.

But the scientists were not satisfied. Back in 1912, an almost forgotten commission had reported that there was a future for biological control of the pest; that there were insects that could hold down cactus growth. In 1920 scientists had persuaded the Governments of the two prickly-pear infested States, Queensland and New South Wales, and the Commonwealth Government, to co-operate and form a *Prickly-pear Board*, which was to work on the findings of the earlier Commission.

Entomologists were sent to America early in 1920, and while the *Queensland Prickly-Pear Board* was making its gloomy announcements, they were working quietly at a field station they had set up in the United States. There were several little insects that were known to be enemies of the pear, but the scientists' problem was bigger than that. Before they could import any of them into the country, they must be sure of several things. The chief of these was, would the insects when imported into Australia, turn on other forms of vegetation? Would they destroy the prickly-pear, only as a prelude to destroying valuable food crops? The scientists had to be sure of these

Dense pear in forest country before insect attack at *Chinchilla*, Queensland (Oct. 1926).



answers, because so much of Australia's production comes from the land.

The patient work went on and before long the scientists found that while there were several parasites that tended to destroy the prickly-pear, one of them was sudden death to it. This was the Moth Borer, known as *Cactoblastis cactorum*, and it came from Argentina. They began to concentrate upon it. They studied its life history and its effect on various hosts. It was found that it could live on the cactus plant and on the cactus plant alone. They found, in fact, that this was the result with almost all of the cactus-attacking parasites. It seems that the cactus family has its own definite insect fauna. Very few of these will live on any other form of foliage, just as very few insects that live on other plant can survive on the cactus.

Having established the fact that the *cactoblastis* would not be a danger to any other plants in the country, scientists felt it would be safe to introduce it into Australia. The field stations in America and the Argentina collected selected insects and their eggs and brought them to Australia. The first batch of eggs arrived in Australia in the larval stage in 1925. During the next spring, the larvæ turned to moths, which laid 100,650 eggs. They were kept in rearing cages, and the next generation numbered 2,540,000 eggs. There was a 900-fold increase in 12 months, for two generations of *cactoblastis* are born every year.

The first experimental liberation went on until the end of 1927. By then 9,000,000 eggs had been distributed in lots of from 100,000 to 250,000 all over the affected country. It was not long before it became obvious that rearing in cages was unnecessary. The insects increased so much in places where they had been liberated, that it was only necessary to collect

the eggs from nearby plants and spread them in other places. Mass distribution began in 1928, and went on until 1930, by which time roughly 3,000 million eggs had been distributed.

The method was simple. The little sticks of eggs were lightly glued to squares of paper or placed in waxed paper quills, and the squares or quills were pinned to the cactus plants. The insects multiplied so rapidly that big gangs of men equipped with trucks had to be employed to spread the eggs far and wide. Within six years of its importation, *cactoblastis* was firmly established from one end of the pear belt to the other.

The result was successful beyond all expectation. By the end of 1928, each liberation area showed about 1,500 acres of ground cleared of cactus, and by 1932, vast tracks of prickly-pears had been reduced to pulp, in a most spectacular manner. (See illustrations.) In fact, in August of that year, 90 per cent. of the pear had disappeared.

But even then the battle was not over. For by killing off the cactus, the little *cactoblastis* was virtually committing "suicide." It could live only on cactus, and that was nearly all gone. The *cactoblastis* began to die off in a most alarming way, and in the meantime the cactus was growing again. The seeds from the rotted plants had fallen to the ground, and because there was no *cactoblastis* to control them, they began to expand just as they had done in the years gone by.

However, the *cactoblastis* had not died out completely, and very soon it was flourishing again. By the end of 1934, all the area of regrowth was under control again, and now, although there are times when the cactus seems to be getting under way once more, there is no cause for alarm. For whenever the cactus starts growing the *cactoblastis* starts too.

Same area showing complete destruction by *Cactoblastis* (Oct. 1929).



NOTES AND NEWS

Alumina from Low Grade Bauxite

THE problem of utilizing low grade ores for the winning of metals has always attracted attention as a means to conserve, as much as possible, the high grade ores, and during the war years it has assumed special significance in some of the countries which were denied the supply of imported high grade ores and thus were forced to use the domestic low grade ores for the continuance of the industry.

The details of a process for the recovery of alumina, as a first step in the manufacture of aluminium metal, either from the low grade bauxite ores containing as high as 10-18 per cent. silica, or from the red mud slurry from the Bayer's process, is described in *Ind. & Eng. Chem., Ind. ed.*, 1945, 37, 796.

It is well known that low silica content is an essential requirement of a good bauxite ore for treatment by the Bayer's process, and on this basis ores containing less than about 7 per cent. silica are classed as high grade ores. Silica causes loss of both alumina and soda by the formation of an insoluble complex, approximately represented as $3\text{Na}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2 \cdot 5\text{H}_2\text{O}$. Calculated on this basis, one lb. of silica present in the ore as clay, results in the loss of 1 lb. of soda ash and 1 lb. of alumina. This soda ash must have to be replaced and lime is necessary to convert the soda ash to caustic soda. In the process described, the first extraction is done by the usual Bayer process and the red mud, containing in some cases as high as 34 per cent. alumina, is mixed with ground limestone and soda ash and sintered in a rotary kiln at 1,800-2,000° F. The amounts of limestone and soda ash are adjusted so that they are in excess of that required to combine with the silica and alumina of the red mud. The sinter is then ground and leached with water to produce a solution of sodium aluminate and caustic soda. After filtering and washing, the residue, which is now largely calcium silicate, is run to waste. The filtered solution which contains sodium aluminate and caustic soda is returned to the digestion in the Bayer's process and the rest of the cycle is followed. The Bayer's process requires 2.01 lbs. of a 6 per cent. silica bauxite per lb. of alumina produced as against 1.80 lbs. required for the combination process. The advantage of the combination process increases at higher silica contents, and for a 13 per cent. silica bauxite, the corresponding figures are 2.80 and 2.20 lbs. respectively and yields of 85-90 per cent. of the total alumina in the low grade ores have been obtained in the commercial operation of the combination process.

A.L.S.

Methoxone

The new selective weed killer, Methoxone—4-chloro-2 methyl phenoxy-acetic acid, produced by the I.C.I. Dyestuffs Division, is outstandingly active in retarding or arresting the growth of weeds, without affecting the cereals. It can be applied in water solution or as dust at rates as low as 8 oz. per acre. The action of methoxone is not yet understood. It is different from the weed killers like sodium chlorate or sodium arsenite which sterilize the soil

so that no vegetable can survive, or from the weed killers like sulphuric acid which adhere to and scorch the foliage of broad-leaved weeds. Methoxone is absorbed by the weeds, causing serious physiological disturbances and ultimately killing the weeds. Methoxone is non-inflammable, non-poisonous and it is not unpleasant to handle.

Methoxone can be applied at any time, but it is best applied after the cereal crop is established, so as to eliminate the competition from the weeds.

Field trials with methoxone carried out in co-operation with the Agricultural Research Council, U.K., showed that out of the 20 common weeds, 5 were killed outright, 6 were seriously affected, 6 were affected and only 3 remained unaffected. The weeds that were killed outright were the most common and their elimination was most beneficial to cereal crops.

Methoxone is sold to farmers as "Agroxone," a form specially suitable for use on the land. The initial cost of application is reckoned at 30s. per acre.

Magnesium Bisulphite for Pulp Process

American paper mills, using the sulphite pulping process to manufacture paper pulp, lose 10,000 tons per day of recoverable lignins, carbohydrates and the chemicals employed in the extraction or cooking operations. In addition, this waste which is pumped out from the paper mills in liquid form to adjoining streams, pollutes the waters, killing fish and plant life. An answer to the problem may be found in a change in the chemical used in the acid process from a calcium base to a magnesium base, a process developed jointly by the *Howard Smith Paper Mills*, Montreal, Canada, and the *Babcock and Wilcox Company*, New York; and independently by the *Weyerhaeuser Timber Company*, Longview, Washington.

When magnesium bisulphite is employed as the cooking liquor, the liquor can be satisfactorily evaporated without scale formation, the chemicals recovered and recycled, and the heat from the combustion of the lignins and carbohydrates used for the efficient generation of steam. While only a small percentage of material now wasted can be used for commercially saleable items such as vanillin, alcohol, yeast, oxalic acid, road binders, cements and lignin plastics, there still remains the problem of the economic disposal of the balance. The waste products might be rendered non-toxic so that fish and marine vegetation would not be injured, but this would constitute an additional cost against every ton of pulp produced by a mill, and, therefore, would be a definite economic disadvantage in the highly competitive pulp industry. Following laboratory and experimental investigations, a semi-commercial pilot plant incorporating the magnesium base operation, was installed at the Cornwall (Ontario) Division of the *Howard Smith Paper Mills* and operated for a sufficient period of time to prove conclusively the practicability and economics of the process (*Chem. Ind.*, July 1945; *U.S.I.S. Chem. Eng. Newsletter*, No. 14).

Vacuum Metallurgy

The vacuum technique, successfully applied for the production of magnesium, may be expected to result in better purification techniques using melting and distillation, and in sounder castings. Use of a vacuum makes it possible to evaporate metals, at greatly reduced temperatures, using large metal surfaces. Apparatus of large cross-section is necessary to insure instant evacuation of the metal vapour. A minimum pressure of 1.8 mm. of mercury is required for rapid flow of the metal vapour to the condenser to ensure practical operation on a commercial scale.

Temperatures to which certain metals must be heated to obtain this pressure are: mercury, 139° C.; caesium, 300° C.; rubidium, 310° C.; potassium, 360° C.; cadmium, 420° C.; sodium, 450° C.; zinc, 505° C.; magnesium, 620° C. (sublimes); strontium, 760° C. (sublimes); lithium, 760° C.; calcium, 850° C. (sublimes); barium 880° C.; lead, 1,020° C.; tin, 1,250° C.; manganese, 1,280° C.; silver, 1,340° C.; chromium, 1,350° C. (sublimes); aluminium, 1,520° C.; beryllium, 1,550° C.; copper, 1,630° C.; silicon, 1,670° C.; iron, 1,860° C.; nickel, 1,930° C.; platinum, 2,630° C.; molybdenum, 3,610° C.; carbon, 3,120° C.; tungsten, 4,000° C. From this list it can be seen that lead is the last metal of the group that can be distilled in heat-resisting steel equipment, since its vaporization temperature at 1.8 mm. is 1,020° C.; while the extreme upper working temperature of the steels is 1,200° C. Tin can be freed from lead as a contaminant in these types of furnaces.

Carbon resistor furnaces, not as yet used commercially, would extend the range to about 1,600° C., above which the vacuum reaction of carbon with refractories becomes serious. High-frequency heating can be used for higher temperatures. Subliming may offer some advantages over distilling, but since the diffusion rate of the metal to the surface of the charge governs evaporation velocity, and diffusion is a slow process, only slightly contaminated metals are suitable for sublimation. Magnesium is purified by this process. Accurate specification of pressure and temperature to be used is necessary in vacuum metallurgy. Large metal losses during evaporation would cause failure if the best possible vacuum were used for melting. The less volatile metals are melted at pressures of 1 to 10 mm.

Some metals, such as chromium and magnesium, cannot be melted in a good vacuum in an open crucible. Similarly, brass cannot be annealed in high vacuum without losing zinc, nor sheet iron at high temperature without losing manganese. Alpac aluminium-silicon alloy loses sodium. Most metals will sublime in an electronic vacuum, such as exists in a radio tube. Alloys may be separated into component metals more easily in a vacuum than at atmospheric pressure. In a high-frequency field, evaporation is higher.—Kroll, *Metals and Alloys*, May 1945; *U.S.I.S., Min. & Met. Eng. News Letter*, No. 13.

Processing of Australian Woods

The utilization of Australian timbers for bonded laminate veneers has been developed by the Division of Forest Products of the *Council for Scientific and Industrial Research*, at Melbourne and, as a result, a large number of propeller blades has been made for bench and for flight tests.

Improvements in manufacturing technique have now resulted in Australian firms bonding their veneers with Tego glue film where a material having

a high impact value is required. By this method it was found possible to employ Australian timber in the manufacture of the *Mosquito* plane. Australian wood processed in this manner was found to have properties equal to English birch.

General uses for the new bonded materials include utilization for ball and roller bearings, gear wheels, brake linings, pulleys and trolley wheels. In the aircraft industry the wood has been found suitable for propellers, joysticks, instrument panels, wireless masts and parking blocks and numerous other applications.

The textile industry has benefited by utilizing improved or densified wood for shuttles and bobbins, and as a substitute for laminated canvas rollers. It has great possibilities in the electrical industry, production having ranged from instrument mounting panels and terminal boards to insulating stools and fish plates for electric railways.

Marketing of Bananas

In their report on the marketing of bananas, the Agricultural Marketing Department of the Government of India suggests that possibilities of increasing the demand of bananas for industrial uses should be explored, and trade in banana fibre and flour, particularly in the surplus banana-producing Provinces and States like Madras, Mysore, Cochin and Travancore, should be taken up.

The area under bananas in India is estimated at 404,550 acres producing about 110 million maunds. The average annual export of bananas during the three years from 1937-38 to 1939-40 was 12,000 maunds only.

The report suggests that banana varieties should be systematically classified and described in all the principal banana-producing Provinces and States. There is also need for standardizing units of price quotation and improving market intelligence. Suggestions have also been made for the extension of the *Agmark* trading and marketing scheme to bananas and the setting up of co-operative sales societies in the chief banana-producing areas.

It is further suggested that possibilities of adopting improved containers for the superior varieties of bananas should be studied and, in order to develop the export trade in these varieties, cold storage may be developed. For transporting bananas, wooden vans with proper arrangements for ventilation should be provided by the railways.

Inquiry into the Indian Coal Industry

A Press communique dated 5th December, 1945, states: "In the last 25 years, three Committees were appointed by the Government of India to inquire into and report on certain defined problems affecting the coal industry in the country. The first of these in 1920 dealt with Mr. Treharne Rees' recommendations for avoiding waste of coal deposits due to defective methods of extraction. A subsequent Committee in 1926 had the more limited objective of proposing measures necessary for stimulating the export of suitable coal from Calcutta to Indian and foreign ports. A third Committee in 1937 reported on measures deemed necessary both for the prevention of avoidable waste of coal deposits and for securing the safety of those employed in the extraction of coal.

"A number of recommendations made by these Committees have been implemented by Government, but others have not been acted upon, primarily

because they were not considered, at the time, feasible or expedient.

"A great deal of attention has been focussed on the coal industry in recent times all over the world. The experience of coal problems in India during the war, especially since the introduction of control over production and distribution, has emphasized the need for vigorous action in respect of both conservation and rationalization if the coal industry is to play its full part in the economic re-planning of the country. The Government of India consider that the time is now opportune for a comprehensive review of the recommendations made by previous Enquiry Committees which have not hitherto been implemented; in addition, investigation of certain fresh problems is also necessary. They have accordingly decided to set up a small Committee to go into the questions set forth in the following terms of reference:—

"*Terms of Reference.*—To review the recommendations made by the various Committees dealing with the problems of the coal industry which were set up by Government from time to time, and to consider (a) which of these recommendations have been adopted and with what measure of success; and (b) what further action needs to be taken by Government in respect of the recommendations which have not been adopted or which have been adopted only in part.

"To consider and to report what further economic and administrative measures are necessary to deal with the problems of the industry of a non-technical character and, in particular, to report on the conservation of high-grade metallurgical and steam coal, the problem of fragmentation of colliery holdings, the opening of new fields, the economics of the coal industry and the stabilization of coal prices.

"*Members and Assessors.*—The Committee will be constituted as follows: Mr. K. C. Mahindra (Chairman); Mr. C. A. Innes, Mr. K. C. Neogy, Mr. M. Ikramullah, (Members) and Mr. P. R. Nayak (Secretary).

"The Committee will be assisted in technical matters by the following Assessors: Mr. J. R. Harrison, Khan Bahadur G. Faruque, and Mr. W. Kirby.

"The Committee will be designated 'The Indian Coalfields Committee' and will have its headquarters at Calcutta. It will assemble early in January, 1946, and will submit its report to Government as soon as possible."

Higher Technical Education in India

An All-India Council for Technical Education has been constituted by the Government of India to study the needs of the country for higher technical education.

The immediate task of the Council will be: (a) to survey the whole field of technical education in consultation with the Provincial Governments and such Indian States as may be willing to co-operate with it; (b) to advise in what areas technical institutions should be established, for what respective branches of technology they should provide and up to what standards they should co-operate; (c) to consider such projects as are already under consideration by various Departments of the Government of India, e.g., the provision of senior All-India Polytechnics on the lines of the *Massachusetts Institute of Technology* or the establishment of a Technical College for Electrical (Power) Engineering, and to assign their functions in an All-India Scheme; and

(d) to conduct preliminary investigations with a view to ascertaining the conditions on which the authorities in control of the existing technical institutes would be prepared to co-operate.

This step has been taken in pursuance of the recommendation of the Central Advisory Board of Education that technical education at the higher (above High School) stages cannot under modern conditions be effectively organized on a provincial basis. Also, because it will help other branches of post-war reconstruction which will demand a larger increase in the available supply of Indian technologists and technicians.

The Council will have, in the first instance, advisory functions only and the decision to set up such a Council is without prejudice or commitment to the full implementation at a later date of the proposals approved in this behalf by the Central Advisory Board.

Mr. N. R. Sarker has been appointed Chairman of the Council. The names of members will be announced later. The tenure of office of the non-official members including the Chairman will be three years. The Council will be attached to the Department of Education, Government of India. A member of the staff of the Department will be the Secretary of the Council.

Survey of Mahanadi in Orissa

The decision to undertake a preliminary survey of the Orissa rivers with a view to preparing schemes of unified and multi-purpose development was taken at a conference held at Cuttack during the first week of November, 1945, under the chairmanship of Dr. B. R. Ambedkar, Labour Member to the Government of India.

It was agreed that, in the first instance, possibilities of controlling and developing the Mahanadi River should be surveyed, and this should be carried out by the Provincial Governments concerned in conjunction with, and under the general direction and supervision of the Central Waterways, Irrigation and Navigation Commission.

It was explained that the Commission would, in the beginning, carry out a preliminary reconnaissance over the entire length of the Mahanadi, and if as a result of such reconnaissance a *prima facie* case for development of the river for the benefit of the Provinces and States concerned was established, further detailed survey and investigation would have to be undertaken. It would only be at this stage that full participation of parties concerned, both administrative and financial, would be necessary. Till then the Central Waterways, Irrigation and Navigation Commission propose to carry on preliminary reconnaissance with the help of the recently created Orissa Rivers Division of the Provincial Government. It was agreed that the C.P. Government and the Eastern States would supply the Central Waterways, Irrigation and Navigation Commission with all such data and information as they already possessed and would co-operate fully with them in order to explore the possibilities of the Mahanadi River.

Dehydrated Vegetables

In response to an invitation by the Central Food Department, representatives of dehydrated vegetable factories met in New Delhi to investigate the possibilities of vegetable dehydration in the civilian economy of the country, now that military demands had ceased.

Explaining the official viewpoint, Mr. Lobo Prabhu, Deputy Secretary, stated that the Food Department was keen to afford technical advice and assistance in obtaining controlled materials and manufacturing plants to the factories to maintain production, but experts were of the opinion that at present dehydration would be a speculative production which would have to proceed cautiously and in stages.

Representatives of the industry decided to explore the possibilities of the market further in the light of the information given at the meeting, and to submit concrete proposals for assistance from the Government.

It is understood that in 1945, 18 factories manufactured about 3,350 tons of dehydrated vegetables for Army requirements.

Raw Rubber Prices

The question of the revision of purchase prices of raw rubber has been under the consideration of the Government of India and it has now been decided that the present purchase prices shall stand upto 31st January 1946. From 1st February 1946 onward, however, the prices of No. 1 RMA Sheet (Group-I) will revert to the basic price of Rs. 77-5 per 100 lbs. delivered at Government Purchase Depot, Cochin.

The prices of other groups will likewise revert to those prevalent in June 1943, as published in Notification No. 16(2)I.P./43 dated 5th June 1943, for Groups I to 7.

Phenol Control Removed

The Central Government have published the Coal Tar Products Control Order, 1945, in the *Gazette of India* dated 8th December 1945. It is a re-issue of the original Control Order with all amendments up to date. One important change is that control over phenol has been removed.

Control on Alumina Sulphate Withdrawn

The Sulphate of Alumina Control Order, 1943, is being withdrawn. It was introduced in April 1943, to ensure adequate distribution of the various grades of sulphate of alumina for essential civil purposes such as paper manufacture, textiles, dyeing, etc.

As a result of the increased indigenous production and of careful husbanding of the available supplies, there are now in the country adequate stocks to meet normal civil requirements.

Indian Commodities and American Markets

In his review of the business conditions in America in September 1945, Mr. S. K. Kripalani, India Government Trade Commissioner in New York, observes that mechanically shelled cashew-nuts from Brazil are beginning to arrive in New York. Experts in the trade are reported to believe that with proper machinery, Brazil will be able to compete with India.

Since the war ended, the situation regarding the American Navy's demand for *kapok* has changed. Future purchases are not likely to be made in India both on grounds of quality and price. Indian *kapok* has a malodorous smell, and the price rules round about 25 cents per lb. It is understood that *kapok* is available from France and Ecuador at 15-16 cents per lb.

Interest has been evinced in certain quarters in the prospects of imports of Indian silk. This is a favourable moment to send in samples, quote prices and test the market with the help of trial consignments.

There has been important inquiries regarding a wide range of arts and crafts products.

Central Board of Irrigation

The need to create River Development Authorities for settling disputes between Provinces and States was emphasized in a resolution of the Central Board of Irrigation at its annual meeting held in New Delhi last month under the chairmanship of Mr. F. H. Hutchinson, Chief Irrigation Engineer, U.P.

Information available from various Provinces and States regarding the existing and proposed irrigation projects was pooled during the discussions. It was felt that the formation of River Commissions was the best way to ensure protection of the interests of all Provinces and States.

By another resolution, the Government of India were asked to set up a committee to advise on data to be collected for assessing indirect benefits from irrigation. Until such time as the monetary value of the indirect benefits can be assessed, the Board recommended that the criterion for judging whether an irrigation project is productive or not should be: that the estimated net revenue shall not be less than the anticipated interest on the sum at charge when the project is fully developed.

Among other decisions were the establishment of close contact with the International Commission for High Dams and the reorganization and transfer from Simla to Delhi of the office of the Board. The Board also examined the work done by the Research Committee in its annual meeting in July last and accepted most of its recommendations.

Rai Bahadur A. N. Khosla, Consulting Engineer to the Government of India and Chairman of the Central Waterways, Irrigation and Navigation Commission, has been elected President of the Board for the ensuing year.

Indian Central Jute Committee

To meet the varied problems of jute, the *Indian Central Jute Committee* had been feeling for some time past that its activities in the various sections needed expansion and reorganization. But due to war exigencies these had perforce to be restricted so long. To examine the accumulated demands in this connection, the war having ended, the Local Sub-Committee appointed three expert Sub-Committees for the present to recommend the lines of expansion and reorganization for the Technological Research Laboratories, the Economic Research Section and the Marketing Section, respectively. It may be recalled that the reorganization of the Agricultural Research Section, which was deemed to be pressing, had already been decided upon and a scheme accordingly approved.

Indian Central Tobacco Committee

The inaugural meeting of the Indian Central Tobacco Committee held in New Delhi, decided that the headquarters of the Committee will be located at Bombay. The Committee also approved proposals to increase the inspectorate staff under the Agricultural Marketing Adviser, in connection with

the Government of India scheme for the compulsory grading of tobacco for export from India.

The Indian Central Coconut Committee

At its recent meeting held at Ernakulam, the Indian Central Coconut Committee decided, *inter alia*:

(1) to sanction schemes for (a) co-operative marketing of copra in Travancore and Cochin, and (b) supply of selected coconut seedlings to growers in Madras, Orissa, Travancore, Cochin and Mysore;

(2) to request the Provincial Governments of Madras and Bombay to put up schemes to overcome by propaganda the existing prejudice against the use of expeller oil-cake (*poonac*) as cattle feed;

(3) to depute an officer of the Travancore Agricultural Department to Ceylon to study improved methods of kiln-drying of copra and advise whether they can be adopted in India; and

(4) to set up special Sub-Committees (a) to examine all the existing data in Provinces and States regarding the research work done on coconuts and to advise the Committee as to the lines of future work, (b) to consider ways and means of converting the present cultivation of coconut on a cottage industry scale to a small plantation basis by consolidation of holdings, and (c) to examine the question of setting up a Technological Institute under the Committee.

Bombay Metallurgical Society

The Bombay Metallurgical Society with 77 Members, 11 Associates, and 18 Firms engaged in metallurgical work, has been recently established in Bombay: Prof. N. P. Gandhi, formerly of the Benares Hindu University, is the President of the Society.

The following papers have been read before the Society: Mr. A. Schwarz, *Antimony Smelting*; Mr. Pranlal Patel, *Technology of Malleable Iron*; Mr. G. C. Mitter, *Electro-chemical Industries*; Prof. N. P. Gandhi, *Design of Industrial Furnaces*; Mr. M. R. Rege, *Casting of Copper*; Mr. C. W. Clarke, *High Duty Cast Irons*; Mr. C. K. Desai, *Hot-Tinning of Steel Hollow-ware*.

A technical library and reading room have been started, and a Museum of Metallurgy is being organized.

Foreign Training for Indian Geologists

The Labour Department in the Government of India, it is learnt, have decided on a scheme for providing foreign University training to Indian geologists. Improvement of Indian University Faculties teaching Geology and practical training in metalliferous mining to stipendiary students are also under consideration.

Foreign training will be given to about 12 to 14 permanent Assistant Geologists of the Geological Survey of India who are now being recruited from among graduates in geology. After recruitment they will be given field training in India for some months and then sent to the University of Melbourne, Australia, for practical training for a period of about eight months. The choice of the Melbourne University is mainly due to two reasons: the geology of Australia is very similar to that of India and the academic year there is from March to October which coincides with the recess period in the Geological Survey of India. The scheme will be operative for three years in the first instance and the first batch of trainees is expected to leave early in 1946.

Scholarships for Overseas Studies

The Imperial Tobacco Co. of India, Ltd., has instituted two studentships of the value of £500 each, tenable for two years, to Indian students for studies abroad in Agriculture with special reference to tobacco. The company has left the studentships to the administration of the Indian Central Tobacco Committee constituted by the Government of India.

Announcements

New Year Honours. Among the recipients of the New Year Honours are the following:

G.C.I.E.: Sir John Ackroyd Woodhead, I.C.S. (Retd.), lately Chairman of the Indian Famine Enquiry Commission.

K.C.I.E.: Sir Ardeshir Dalal, I.C.S., Member of the Governor-General's Executive Council; Mr. James Bennett Hance, Director-General, Indian Medical Service.

Knighthood: Mr. John Sargent, Secretary to the Government of India in the Department of Education; Mr. H. R. Stewart, Vice-Chairman, Imperial Council of Agricultural Research; Mr. Frank Ware, Director of Animal Husbandry, U.P.; Lieut-Col. Sahib Singh Sokhey, Director, Haffkine Institute, Bombay.

C.I.E.: Sardar G. Cheema, Horticulturist to Government and Principal, Agricultural College, Poona; Col. S. L. Bhatia, Inspector-General of Civil Hospitals, Assam; Mr. R. C. Srivastava, Director, Imperial Institute of Sugar Technology, Cawnpore; Mr. P. H. Carpenter, Director, Scientific Department, Indian Tea Association, Tocklai, Assam.

C.B.E.: Mr. C. W. Goyder, Chief Engineer, All-India Radio.

M.B.E.: Dr. Lal C. Verman, Director, Physical Laboratories, Council of Scientific and Industrial Research, Delhi; Dr. S. Siddiqi, Director, Chemical Laboratories, Council of Scientific and Industrial Research, Delhi.

Council of Scientific and Industrial Research. The Hon'ble Sir Akbar Hydari was re-elected Vice-President of the Council at the meeting of the Governing Body of the Council held in New Delhi on 18th January 1946.

The Hon'ble Dewan Bahadur Sir A. Ramaswamy Mudaliar, has been elected Chairman of the Economic and Social Council of the United Nations Organization.

National Institute of Sciences of India. Prof. A. F. Blakeslee, Prof. R. A. Millikan and Prof. P. Niggli, were elected Honorary Fellows of the Institute at the meeting of the Council held on 19th November 1945.

Indian Science Congress Association. Pandit Jawaharlal Nehru has been elected President of the Indian Science Congress, 1947. The next annual meeting will take place at Patna during the 1st week of January 1947.

Index of Industrial Raw Materials. The Economic Adviser's All-India Index of wholesale prices of Industrial Raw Materials worked out to 260 for the week ended 29th December 1945, as compared with 254 for the previous week.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for October-November, 1945.]

32694. ADVERTISING APPARATUS: *Comprising a plurality of pairs of spindles, each pair associated with a tape bearing letters and characters and a slotter display board over which the tapes are traversed side by side whereby advertisement built up.*—Zell.
32741. GRASS-BOX FOR LAWNMOVERS: *Top and bottom walls hinged to fold towards one another and the end walls hinged to fold inwards.*—J. P. Engineering Co., Ltd.
28997. ACETIC ACID: *Treating paraldehyde, in the presence of a depolymerising agent therefor, directly with oxygen or an oxygen-containing gas.*—The Distillers Co., Ltd., Staudinger, Tuerck and Brittain.
28998. CONCENTRATION OF AQUEOUS ACETIC ACID: *Aqueous acetic acid is dehydrated by distilling the water in azeotropic admixture with paraldehyde.*—The Distillers Co., Ltd., Staudinger, Tuerck and Brittain.
30354. METAL BODIES, PARTICULARLY THOSE ADAPTED TO WITHSTAND HIGH TEMPERATURES: *Metal resistant to chemical attack but liable to creep reinforced by skeleton of another metal liable to chemical attack but immune from creep.*—G. E. C. Ltd.
30931. PIEZO-ELECTRIC OSCILLATORS: *Inductor across terminals of the crystal.*—G. E. C. Ltd.
31427. A PORTABLE AIR-CONDITIONING APPARATUS: *Centrifugal blower blowing spray of water raised from a tank below.*—Dutta Gupta.
31428. ECCENTRIC ROTARY PUMP: *Projecting non-metallic blades held in annular grooves cut into the stator made of metal and pressed by springs.*—Dutta Gupta.
31512. SAFETY RAZORS: *Blade is given a reciprocating motion.*—Warburton.
31661. ACTIVATION OF CLAYS: *Hydrocarbon is passed through a catalyst prepared by digesting clay in acid.*—Standard Oil Development Company.
31757. EXPLOSIVE COMPOSITIONS: *Explosive composition including as gelation agent a metal oxide or hydroxide or a normal or a basic salt.*—E. I. Du Pont de Nemours and Co.
31781. ACID STEEL OR IRON: *Adding an acid containing ore directly to the stream of molten metal.*—Jamshedpur Engineering & Machine Manufacturing Co., Ltd.
31865. ANTI-FOAMING COMPOSITIONS, PARTICULARLY FOR USE AS LUBRICANTS: *Comprising an organic liquid and a small amount of polymerised hydrocarbon silicone or dihydrocarbon silicate.*—Shell Development Co.
31910. TUNING ARRANGEMENTS FOR WIRELESS RECEIVERS AND THE LIKE: *Click mechanism for receiver tuners where the click element is electromagnetically urged to engagement position.*—Philips Lamps Ltd.
31957. NUT AND SCREW FASTENINGS: *Tapered bore of nut is mutilated by smooth surfaced bays on opposite sides of the axis and by an annular recess in the central region.*—Walker and Elsdon.
32072. PEN-HOLDERS: *A nib to be inserted in a pen holder having a writing point at each end with different characteristics.*—Chooet-Smith.
32085. DRILLING MACHINES: *Reciprocating work support in spring urged. Cam operated rocking lever performs return movement.*—Philips Lamps Ltd.
32086. DRILLING MACHINES: *In drilling machine for diamonds, used as wire dies, shape of drill is restored by mechanically retraction work support and advancing grinding wheel to engage the drill. Movements effected by two cams mounted on cam shaft driven from main drive.*—Philips Lamps Ltd.
32154. BACTERICIDAL, TOXIC OR LIKE EMULSION: *Production of composite emulsions containing tonic agent having bactericidal, insecticidal and like properties.*—International Bitumen Emulsions Ltd.
32194. WATERPROOF PAPER AND PAPER BOARDS: *Treatment of paper pulp with coal tar pitch emulsions followed by breaking of the emulsion before felting of the paper, giving water proofing properties to the paper.*—International Bitumen Emulsions Ltd.
32239. MEDICAL SYRINGES: *Reinforcing syringe forward end and closure member by an outer metal band.*—Everett.
32306. SEPARATION OF SULPHUR DIOXIDE FROM CHLORINE: *Distilling the liquid mixture at one pressure and then distilling the distillate at a second pressure.*—E. I. Du Pont de Nemours and Co.
32314. APPLYING COATINGS TO SURFACES, MORE PARTICULARLY TO THE SURFACE OF ELECTRONIC DEVICES: *Barium carbonate forming the coating material is suspended in a solution of a thermoplastic organic synthetic resin in organic solvents, such as ketones and alcohol.*—The Mullard Radio Valve Co., Ltd.
32377. SHORTHAND TYPEWRITING MACHINES: *Vowel keys at centre, initial and final consonants left and right; certain key positions correspond to those of digits tips when hands naturally laid on key board.*—C. C. M. Palanque.
32490. STROPPING OR SHARPENING SAFETY RAZOR BLADES: *A holder for sharpening safety razor blades comprising a handle and a clamp for the blade.*—Lutersz.
32620. CIGARETTE AND CIGAR HOLDERS: *With tubular cap.*—Alltools Limited, and Petrie.
32647. PNEUMATIC SHOCK ABSORBER: *Carriage chassis fixed to terminal of a buffer plate between two pneumatic rubber cushions in a case attached to wheel axle.*—Kolandaismamy.
32649. A COMBINED SHOVEL AND HOE: *Having pivotal connection between the blade and handle.*—Bevin.

32697. ARRANGEMENTS FOR THE TAKING OFF OF CONNECTIONS FROM ELECTRIC CABLES: *The branch connections from main electric cables can be selected and changed by means of detachable contact making metal blocks between the main cable conductors and bush-bars associated with the branch circuits.*—Henley's Telegraph Works Co., Ltd.
30761. CONTROL OF PLANT COMPRISING FREE-PISTON GAS GENERATORS AND TURBINES: *Regulating the plant in one zone by varying the quantity of fuel injected into the gas generator and in another by varying the said quantity and by throttling the gas entering the turbine.*—Pescara.
30947. CONDUCTOR ROLLS FOR USE IN ELECTROPLATING: *Hollow tubular roll of high conductivity divided into sections.*—Carnegie-Illinois Steel Corp.
31186. ROTARY VALVES OF INTERNAL COMBUSTION ENGINES, COMPRESSORS AND THE LIKE: *Individual sealing members for lubricant and coolant.*—Aspin.
31203. FUEL-MIXTURE COMPRESSION INTERNAL COMBUSTION ENGINES: *Air-space formed between cylinder cover and working piston at inner dead centre communicates with combustion chamber and ignition means at outlet of air-space.*—Bischof.
31235. METHODS OF COATING PAPER, PAPER BOARD AND THE LIKE FELTED FIBROUS WEBS: *Passing web between oppositely rotating rolls, each roll being driven at a surface speed of opposite sign of about 25 per cent. to 10 per cent. different from translatory speed of web.*—Consolidated Water Power and Paper Co.
31363. CHEMICAL REACTION TOWERS, PARTICULARLY FOR THE DIGESTION OF VEGETABLE MATERIAL IN THE MANUFACTURE OF PAPER PULP: *Rotatable drum with shallow teeth on the surface for moving the pulp.*—Cellulose Development Corp. Ltd.
31382. JOINTING DEVICES FOR ELECTRICAL CABLES, WIRES AND THE LIKE: *Connector comprising open-ended tube containing charge of solder and flux.*—Dowding.
31517. ELECTRIC SECONDARY BATTERIES: *Pack comprised of pasted plates and sheets of porous separating material.*—Varley Dry Accumulators Ltd.
31599. PLATES OF ELECTRIC ACCUMULATORS: *Bottom bar having vertical ribs in alignment with ribs of retainers.*—The Chloride Electrical Storage Co., Ltd.
31600. ELECTRIC ACCUMULATORS: *Slotted tubular retainers the slots disposed at an angle other than right angle.*—The Chloride Electrical Storage Co., Ltd.
31974. POLYMERS OF ETHYLENE: *Heating polythene at high temperature in inert atmosphere and collecting products.*—I.C.I., Ltd.
32006. POLYMERIC MATERIALS: *Polymerisation of vinyl fluoride under pressure and temperature and in presence of small amounts of oxygen and acetylene to give useful polymers.*—E. I. Du Pont de Nemours & Co.
32384. A MACHINE FOR HUSKING AND/OR SPLITTING FOOD GRAINS, SUCH AS MAHSOOR, MUNG, URD AND LIKE PULSES: *Abrasive roller and perforated casing driven in opposite direction at different speeds.*—Varshney.
32524. GRINDING AND FORCING MACHINE: *Feed screw forcing the material to grind the same to a paste or to force it through dies.*—Chadray.
32590. ELECTRIC EDDY CURRENT BRAKES, DYNAMOMETERS AND CLUTCHES: *Axial slots in armature drum form air outlet orifices; sections between slot act as fan blades inducing cool air over hot eddy current surfaces.*—Heenan & Froude Ltd.
32595. ALARM TO PREVENT THEFT: *The ceasing of high frequency oscillations in a thermionic valve oscillator due to a person approaching or touching the object causes a relay to operate bell, siren, etc.*—Trivedi.
32759. MOUNTING OF ELECTRIC TERMINALS OR THE LIKE: *A bush of resilient material supporting the terminal, secured to the upstanding edge produced in the wall of a container.*—The Telegraph Condenser Co., Ltd.
32886. WAVE GUIDES FOR HIGH FREQUENCY ELECTRIC CURRENTS: *Neither of the two rubber-backed inter-woven sets of wires makes, with a plane containing the axis and normal to the wall of the tube, an angle lying between 0° and 45°.*—Callender's Cable and Construction Co., Ltd., Hollingsworth and Morley.
31330. PLUG COCKS: *Plug rotates between seatings which are separate from cock casing and are supported by flexible diaphragms.*—The Saunders Valve Co., Ltd.
31339. FERROUS CASTINGS HAVING DESIRED PHYSICAL PROPERTIES: *Withdrawing casting from mould after solidification and cooling outside mould.*—Mechanite Metal Corp.
31507. TACHOMETER GENERATORS: *Two field windings one being connected to a source of Direct Current supply and other to armature of generator.*—Carnegie-Illinois Steel Corp.
31508. CONTROLLING POWER OUTPUT OF TRANSFORMERS: *Two transformers having primary windings in parallel with each other but in series with load.*—Carnegie-Illinois Steel Corp.
31522. REFRIGERATION APPARATUS: *Material stored maintained at same temperature as refrigerant in evaporator.*—Morrison.
31573. TUNING ARRANGEMENTS FOR RADIO-RECEIVERS: *Means for feeding harmonics of fundamental frequency of oscillation generator into aerial circuit.*—Marconi's Wireless Telegraph Co., Ltd.
31578. PISTONS FOR INTERNAL COMBUSTION ENGINES: *Within the body a plurality of tapering ribs extending generally in the direction of axis of the piston if crown to gudgeon pin bosses.*—Specialoid Ltd.
31592. DYNAMO ELECTRIC MACHINERY AND PRIME MOVERS THEREFOR: *Both field magnets and armature capable of rotation but in opposite directions.*—Blackstone & Co., Ltd.
31618. VICES FOR BENDING AND FORMING SHEET METAL, STRIP METAL, WIRE AND THE LIKE: *Slide rods attached to one jaw and passing through each of the flanges of the other jaw of the body of the vice formed of a channel section.*—Stott.
31623. ATOMISATION OF LIQUIDS: *Directing a spray of atomised liquid against the surface of liquid.*—Trier.
31656. WEIGHING APPARATUS: *Location of bearing blocks forming part of the bearing link within recesses formed by integral projections or shoulders on the lever.*—W. & T. Avery Ltd.
31659. PLATFORM WEIGHING MACHINES: *Stool frame assembly having pair of side members with bearing receiving recesses and support for bearing blocks.*—W. & T. Avery Ltd.

31680. PORTABLE ROTARY HOES: *A transverse rotor with earth-working tools at the end of a control beam with power plant driving the rotor and driving wheels which retained at adjusted depth.*—Howard and Rotary Hoes Ltd.
31745. ELECTRIC CONDUCTOR FOR OVERHEAD SUSPENSION: *A smooth hollow cylinder with a narrow helical gap in the wall; means for resisting the collapse of the cylinder under tension, also provided.*—Callender's Cable & Construction Co., Ltd.
31820. SOLDERING TOOLS: *Electrical connection between a rod-like electrode located within a nozzle-like electrode established by contact of both electrodes with work-piece 1 by spring pressed.*—Standard Telephones and Cables Ltd.
31831. A THERMIONIC VALVE SWITCHING CIRCUIT: *Switching circuits includes grid controlled hard vacuum gas filled valves. Potentials applied must be the gas filled valve conductive; inclusion of the hard valve render the other valve non-conductive.*—Marconi's Wireless Telegraph Co., Ltd.
31855. COIL WINDING: *Guide for thread reciprocated by a reversible, rotating, screw threaded shaft, having a driven friction member, a reciprocable member and a spring.*—H. J. Enthoven & Sons Ltd. and De Ville.
31899. APPARATUS FOR COOLING OR ATTEMPERATING OIL: *Controlling oil flow by providing perforate baffles in shorter oil paths through matrix.*—I.C.I. Ltd.
32050. DEVICES FOR SHARPENING RAZOR BLADES: *Razor blade sharpening device with readily securable and detachable spring member providing pressure between friction sleeve and blade.* Rools Razor Ltd.
32133. BRIDGES AND BRIDGE-LIKE STRUCTURES MADE WITH STANDARDIZED PARTS: *Multiple depth bridge having unitary web bracing members of increased length extending from upper to lower chord and crossed in lattice fashion.*—Hamilton.
32309. COATING OF METAL ARTICLES WITH A POLYMER OF ETHYLENE: *Metal articles coated with ethylene polymer as a thin film, coated metal articles being baked at 200° C.*—E. I. Du Pont de Nemours & Co.
32370. A LAMINATED PRODUCT OF IMPREGNATED FABRIC SHEETS AND METHOD OF FORMING SAME: *Impregnating fabric with an adhesive carried in a volatile solution, superposing sheets and evaporating the volatile.*—Walter.
32392. ELECTRIC SIGNALLING SYSTEMS FOR INDICATING THE PASSAGE OF MOBILES ON AERODROMES: *Microphones are spaced along the runway of aerodrome to receive the noise of the approaching mobile and the voltage developed is transmitted to a central station operating a particular cathode type lamp indicator to showing the position of the mobile.*—Standard Telephones and Cables Ltd.
32477. GRAPHITE CRUCIBLES: *Water-glass acting as a cementing material in a mixture of graphite and refractory clays.*—The General Carbon Co.
32478. ELECTROPLATING A COATING OF AN ELECTRICALLY CONDUCTING METAL ON THE CUPROUS OXIDE SURFACE OF A MEMBER: *Electroplating nickel in electrolyte of nickel sulphate having cuprous oxide coated cathode member on reduced metallic copper surface.*—Westinghouse Electric and Manufacturing Co.
32733. PENICILLIN: *Cultivating Penicillin producing organisms in the submerged condition in contact with an aqueous nutrient medium.*—Moyer.
32807. DOFFING MECHANISMS FOR SPINNING FRAMES: *Carrier-means for receiving and moving banks of bobbins comprising a traversing-screw mechanism on which the bobbin-banks are received and carried.*—Morrison and McGregor Gunn.
32826. APPARATUS FOR THE FILTRATION OF LIQUIDS: *A rotatable header mounted in a closed casing and connected with hollow filter elements whereby solids are collected in and removed from the surface of the elements by centrifugal force.*—Brownlow.
32838. TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINES: *Ducts communicating the exhaust and exhaust super-charger arranged or controlled to obtain a low pressure zone near cylinder and high pressure zone at the super-charger.*—Sir W. G. Armstrong Whitworth & Co. (Engineers), Ltd.
32841. MULTI-CYLINDER TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINES: *Exhaust action of one cylinder utilised to super-charge the preceding cylinder.*—Sir W. G. Armstrong Whitworth & Co. (Engineers), Ltd.
32842. MULTI-CYLINDER TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINES: *Exhaust orifices of each cylinder connected by a separate supercharging duct to the inlet orifice of one other cylinder.*—Sir W. G. Armstrong Whitworth & Co. (Engineers), Ltd.
32854. PROJECTILES FOR MORTARS: *Explosive charge housed in a charge casing having a nose-piece with a detonant cartridge and a tail piece with a propellant cartridge.*—Kula and de Lubicz-Bakanowski.
32855. FOLDING PUSHCAR OR WHEELD CHAIR: *A pushcar and the like in which wheels are sprung and carried by hinged blade spring.*—Ford.
32864. SUPPORTING PLANTS AND OTHER ARTICLES FROM STAKES AND THE LIKE: *A loop with shank in combination with clip.*—Gerhold.
32877. TENSIONING REINFORCEMENTS: *Developing an elemental stresses at successive points of the reinforcement and shifting the points step by step.*—Freyssinet.
32991. LAEVULOSE FROM VEGETABLE MATERIALS: *Juices are subjected before hydrolyzing complex glucides to two separate treatments, one by means of heat in absence of acid, the other by means of acids at a low temperature.*—Les Usines de Melle (Societe Anonyme).
31066. PRE-STRESSED REINFORCED CONCRETE SLEEPERS: *Sleeper moulds arranged in series run on tracks in production lines.*—Bernier.
31067. PRE-STRESSED REINFORCED CONCRETE SLEEPERS: *A metal anchor is arranged to engage each reinforcing wire at the end of the mould.*—Bernier.
31068. PRE-STRESSED REINFORCED CONCRETE SLEEPERS: *Parallel reinforcing wires are placed in production lines and concrete filled mould is slid along said line.*—Bernier.
31324. WIPERS OR DIES FOR USE IN THE COATING OF WIRES: *Piece of sheet metal partially divided by a cut extending from one edge beyond a hole which forms the die aperture.*—Henley's Telegraph Works Co., Ltd.
31369. MACHINE TOOLS, PARTICULARLY CUTTING TOOLS: *Shank, separable tip-piece and means for removably securing the tip-piece to the shank.*—Dearden.

31394. STEAM BOILERS: *Fire brick for making roof has horizontal hole to take rods.*—John Thompson (Wolverhampton), Ltd.
31490. COMPARATORS: *A device having in combination a hollow housing and a gauge member, a lever, a face plate, a pointer member in said housing.*—Woodworth Co.
31506. ELECTRONIC CONTROLS, PARTICULARLY FOR CONTROLLING SUPPLY OF POWER TO CONDUCTOR ROLLS OR OTHER MECHANICAL OR ELECTRICAL UNITS: *Detector tube with resistor in series and two power tubes with grids connected to resistor.*—Carnegie-Illinois Steel Corp.
31607. CLAD METALS: *A thin adherent layer of phosphorous copper placed between cladding alloy (Cu-Ag) and the basis metal body (Cu), heated, pressed and rolled.*—I.C.I., Ltd.
31675. CORROSION PROTECTION IN REFRIGERATORS: *Using corrosion preventive substance soluble both in absorbent and refrigerant.*—Aktiebolaget Elektrolux.
31751. SHAPING LATTICE ELEMENTS AND THE PRODUCTION OF STRUCTURAL MEMBERS THEREFROM: *Bending the stock simultaneously about three fulcrums between each two successive feeding steps.*—The Trussed Concrete Steel Co., Ltd. and D. H. Green.
31774. TRANSMITTING INDICATIONS OF THE POSITION OR CONDITION OF A PRIMARY ELEMENT OR MEMBER TO A REMOTE POINT: *Means for transmitting indications regarding the position or condition of different elements of an engine, to a remote point.*—Reid & Sigrist, Ltd.
31777. ELECTRIC CONDENSERS OF VARIABLE CAPACITY: *A fixed plate for one electrode, two plates for the other electrode of which one is fixed and the other longitudinally separable from the former.*—Faber.
31790. APPARATUS FOR WITHDRAWING AND DELIVERING MEASURED QUANTITIES OF MIXTURES OF LIQUIDS AND/OR SOLIDS HAVING AN UNIFORM CONSISTENCY: *Container with cylindrical inner surface having rotatable stirring arm with buckets pivoted at each end automatically getting filled and emptied by dumping under gravity.*—General Foods Corp.
31818. HEAT EXCHANGE DEVICES: *Of matrix type with tubular elements expanded at extremities, peripheral lengths of expanded and intermediate narrower portions being equal.*—I.C.I., Ltd.
31832. PRE-STRESSED CONCRETE: *Clamping end of wire or rod reinforcement between an enwrapped reinforcement-stretching member, and a surface on the means which stretches.*—Stent Precast Concrete, Ltd. and Stent.
31885. COMPOSITE OR PRE-FABRICATED STRUCTURES, SUCH AS CONTAINERS, BOXES, PARTITIONS, HOUSING AND FURNITURE: *A panel sheet having marginal self-locking flanges, wedge-fitting into the longitudinal groove formed of opposed walls of the frame member.*—Lindsay and Lindsay.
31929. NUTS FOR SECURING ROAD WHEELS TO MOTOR VEHICLES AND FOR ANALOGOUS PURPOSES: *Nut is radiused proud at one end face with a plurality of radiating slits.*—Berry, Quilter and Wilkerson.
31972. FOUNDRY MOULDING MACHINES: *A mast, a jib, a ramming head, two endless conveyors and variable speed motor with control means.*—Beech.

Council of Scientific and Industrial Research

PATENT NOTICE

It is hereby published for general information that the following are among the patents sealed in respect of processes developed under the auspices of the Council of Scientific and Industrial Research.

Subject	Indian Patent No.
Cold moulding composition for the manufacture of moisture-resistant or insulating articles such as boards, switches, bottle-caps, trays, panels for radio receiving sets or the like	30316
An improved pencil eraser	30503
A process and apparatus for the production of ammonium carbamate	29967
An apparatus for the production of urea	29969
A method of and composition for lining and seaming containers	30196
A collapsible tube or the like container and a method of making the same	29128
An ice bag or like container and a method of making the same	30072
A process for the manufacture of sintered glassware	30451
Improvements in or relating to the production of foam generating substances	30679
Improvements in or relating to the manufacture of containers, receptacles, hollowware or the like from resin impregnated laminations	30680
Varnish from castor oil products	31284
Improvements in or relating to the manufacture of moulding powders	31282
Anthraquinone vat dyestuffs	31594

STUDIES IN THE CONESSINE SERIES

PART 7—ACTION OF POTASSIUM PERMANGANATE AND CHROMIC ACID ON CONESSINE

By SALIMUZZAMAN SIDDIQUI AND VISHWA NATH SHARMA

(Chemical Laboratories, Council of Scientific and Industrial Research, Delhi)

IN a preceding paper of this series¹ the action of concentrated sulphuric acid on conessine has been described at length. It has been noted in this connection that sulphuric acid under certain definite conditions of temperature, concentration and time of reaction, converts conessine into *iso*-conessine through the intermediate isomer, *neo*-conessine, which is subsequently oxidized under more drastic experimental conditions into a series of oxidation bases in which both the nitrogen atoms remain intact. From the analytical data, these bases appeared to be tetra- or hexa-dehydro-tri-oxy-conessine and tetra-dehydro-dioxy-conessine, but no definite conclusions could be arrived at in respect of these products as they are amorphous in character. The same objection holds good for the lactonic acid obtained by Giemsa and Halberkann² through the chromic acid oxidation of di-oxy-conessine. On the other hand, as already communicated by the present authors³, the usual methods employed for the dehydrogenation of conessine invariably result in the elimination of both the nitrogen atoms, yielding a mixture of hydrocarbons corresponding to the general molecular formula, $C_{21}H_{30}$, and containing an aggregate of three double bonds in place of one present in conessine. These findings indicate that stepwise oxidation and dehydrogenation of conessine might eventually lead to a conversion of the hydro-aromatic nucleus of conessine to a partial or complete aromatic ring system which is likely to yield identifiable simpler bases through subsequent degradation.

In the light of the facts noted above, a comparative study of the action of various oxidizing agents on conessine under milder and more drastic conditions was undertaken. The present paper deals with the results of studies in the action of potassium permanganate and chromic acid and the general behaviour of the oxidation products.

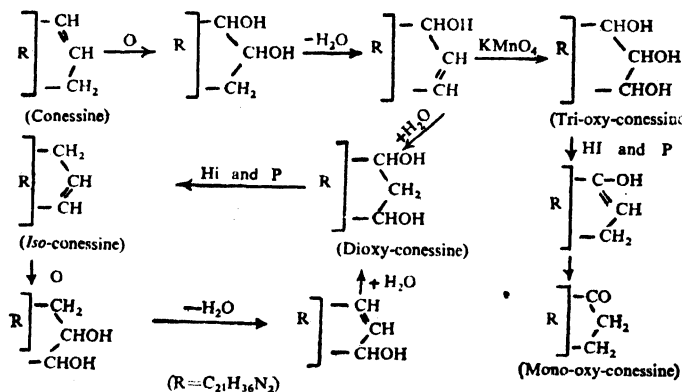
When conessine is treated with potassium permanganate (2.5 moles) in the cold in faintly acid medium, it gives a crystalline

base melting at 273° C. along with the unreacted base. In fixing up the optimum conditions for the reaction, it was noted that an increase in the quantity of potassium permanganate or a rise in temperature adversely affects the yield of the crystalline products. The method described in detail in the experimental section, gives an overall yield of 65 to 75 per cent. of the crystalline bases, but the proportion of unreacted conessine to the new base shows considerable variation in spite of strict adherence to the experimental conditions.

The analytical data and a general study of the new base show it to be a tri-oxy derivative of conessine. It is saturated to bromine and the absence of the double bond is further shown by the fact that it does not give any coloration with tetra-nitro-methane in chloroform solution. It failed to react with phenyl hydrazine, hydroxylamine, benzoyl chloride or benzoic anhydride under the usual conditions. Its colour reaction with concentrated sulphuric acid is similar to that of dioxy-conessine. It thus dissolves to a light yellow solution which turns reddish brown on warming and lightens in colour on dilution with water.

The formation of tri-oxy-conessine under the conditions employed appears to be due to the loss of a molecule of water from the initially formed dihydroxy compound and the subsequent addition of two hydroxyls at the resultant double bond. It is significant to note in this connection that *iso*-conessine on oxidation with potassium iodate and sulphuric acid yields a base which appears to be identical with di-oxy-conessine, obtained by Warnecke⁴ through similar oxidation of conessine, and further that when di-oxy-conessine is treated with hydro-iodic acid and red phosphorus, the reduction base obtained is identical with *iso*-conessine. These apparent anomalies can be explained by assuming that the addition of two hydroxyl groups at the point of unsaturation in conessine as well as in *iso*-conessine is followed in both cases by loss of a molecule of water, and its

subsequent addition during the liberation of the base with alkali whereby the hydroxyls occupy apparently more stable and non-adjacent positions. The formation of the di-oxy base and its reduction to *iso*-conessine could, in that case, be visualized by the following provisional set of formulæ.



The comparative lability of the double bond in conessine as evidenced in the above representation and the formation of its two isomers, *neo*- and *iso*-conessine, may also account for the reduction of tri-oxy-conessine with hydro-iodic acid and red phosphorus to a product which has been identified with mono-oxy-conessine, obtained earlier by the present authors⁵ through reduction of nitro-conessine.

The action of chromic acid on conessine in glacial acetic acid medium in the hot, results mainly in the formation of tetra-dehydro-mono-oxy-conessine melting at 159° C., along with small quantities of dehydro-di-oxy-conessine melting at 288° C. Tetra-dehydro-mono-oxy-conessine does not react with phenyl hydrazine, acetic anhydride or benzoic anhydride under the usual conditions. It appears to be fairly unsaturated as it gives an instantaneous yellow coloration with tetra-nitro-methane, and its hydrobromide slowly adds on bromine in glacial acetic acid solution. In view, however, of the unusual behaviour noted for the conessine series of bases towards bromine⁶, the exact degree of unsaturation in tetra-dehydro-mono-oxy-conessine could not be conclusively established. In contrast to tetra- or hexa-dehydro-tri-oxy-conessine and hexa-dehydro-di-oxy-conessine which have been reported by Siddiqui and Vasisht (*loc. cit.*) to give direct blue or green coloration with

concentrated sulphuric acid, tetra-dehydro-mono-oxy-conessine dissolves with a light yellow coloration which deepens on warming and passes from greenish violet to violet on dilution with water. It would appear from this observation that the sequence of colours produced when conessine is dissolved in concentrated sulphuric acid should be brought about by the products of further oxidative degradation, which may be present as impurities in the amorphous bases referred to above.

In contrast to tetra-hydro-mono-oxy-conessine, the second base obtained through the action of chromic acid on conessine, namely, dehydro-di-oxy-conessine, is saturated to bromine and does not give any coloration with tetra-nitro-methane. A detailed investigation of this base could not,

however, be undertaken as the quantity of the substance at our disposal was limited.

The result of the present investigation fully bears out the stability of the conessine molecule to oxidative degradation. Studies in further oxidation and dehydrogenation of di-oxy and tri-oxy conessine are in progress. It may be noted in this connection that the oxidation of di-oxy-conessine with dilute nitric acid, under well defined conditions, has already resulted in its conversion to a crystalline oxidation base which will be dealt with in a future communication.

Experimental

Action of Potassium Permanganate on Conessine.—10.0 gms. conessine was dissolved in 25 c.c. of 20 per cent. dilute acetic acid and to the solution which was cooled in a freezing mixture, 5.0 gms. of pot. permanganate dissolved in 100 c.c. of water were added drop by drop with mechanical stirring while the temperature was maintained below 0° C. After the addition of the permanganate solution, the reaction mixture was left overnight in the cold and filtered from the MnO₂ sludge, which was repeatedly washed with hot dilute acetic acid. The combined filtrates and washings were concentrated *in vacuo* to about 20 c.c. The concentrated solution was made alkaline with dilute sodium hydroxide and the precipitated base filtered, washed with water and dried

on a porous plate. The petrol ether soluble fraction of the base proved to be mainly conessine (3.5 gms.) with traces of (0.2 gms.) tri-oxy-conessine which crystallized out from a concentrated petrol ether solution. The residue left after extraction of the base with petrol ether melted at 255° C. (4.0 gms.) and after a few crystallizations from methanol finally gave pure tri-oxy-conessine, m.p. 269° C. (Total yield of the tri-oxy base on the weight of conessine actually used up during the reaction works out to nearly 66 per cent.).

Tri-oxy-conessine, $C_{24}H_{42}N_2O_3$: The base is fairly soluble in alcohol or methanol in the hot, sparingly soluble in other organic solvents. From methanol it crystallizes in colourless rectangular rods and cubic plates. It begins to darken in colour from 263° C. onwards, softens at 266° C. and melts at 269° C. In 1 per cent. alcoholic solution it showed $\left[\alpha \right]_D^{18} = +26.2^\circ$. It does not give any coloration with tetra-nitro-methane in chloroform solution and does not decolorise permanganate solution. In concentrated sulphuric acid it dissolves with a light yellow colour which deepens on warming and which lightens on subsequent dilution with water. In concentrated nitric acid it is not affected by warming or subsequent dilution with water. Found after drying to constant weight at 100° C. *in vacuo* over P_2O_5 , C, 70.9; H, 10.6; N, 6.8; $N-CH_3$, 11.2; $C_{24}H_{42}N_2O_3$ requires C, 70.9; H, 10.3; N, 6.4; $N-CH_3$ (for three methyls), 11.1 per cent.

Tri-oxy-conessine hydrochloride was obtained by addition of ether to a solution of the base in alcoholic hydrochloric acid as a white crystalline powder which crystallized from a mixture of alcohol, acetone and ether in colourless rectangular plates easily soluble in alcohol, methanol or water and melting at 341° C. (decomp.). After drying to constant weight at 100° C. *in vacuo* over P_2O_5 , found Cl, 15.0; $C_{24}H_{42}N_2O_3 \cdot 2HCl$ requires Cl, 14.8 per cent.

Tri-oxy-conessine chloroplatinate, was obtained in long orange coloured rods and needles when a solution of platonic chloride was added to an aqueous solution of the hydrochloride. It darkens in colour at 267° C. and abruptly decomposes at 273° C. Found after drying at 100° C. *in vacuo* over P_2O_5 to constant weight, Pt, 23.5; $C_{24}H_{42}N_2O_3 \cdot H_2PtCl_6$ requires, Pt, 23.9 per cent.

Tri-oxy-conessine picrate, was prepared by adding an aqueous solution of picric acid to a solution of the hydrochloride. It is fairly soluble in methanol, sparingly so in water and crystallizes from hot aqueous solutions in bright yellow aggregates of rods which melt at 163° C.

Tri-oxy-conessine methobromide was prepared by adding methyl bromide to a chloroform solution of the base. It was obtained as a white crystalline powder which effervesces at 340° C. Found after drying at 100° C. *in vacuo* over P_2O_5 to constant weight, Br, 16.9; $N-CH_3$, 10.7; $C_{24}H_{42}N_2O_3 \cdot CH_3Br$ requires Br, 15.9; $N-CH_3$ (for four methyls), 11.9 per cent.

Reduction of Tri-oxy-conessine to Mono-oxy-conessine.—0.3 gms. of the base in 4.0 c.c. of hydro-iodic acid was refluxed with 0.2 gms. of red phosphorus in a metal bath at 130–40° C. for about an hour. The reaction mixture was diluted with water and filtered. The filtrate was concentrated to a small volume and kept overnight in the cold, when colourless, prismatic rods (m.p. 345° C. decomp.) crystallized out. After a few crystallizations from water with charcoaling, a product melting at 352° C. (decomp.) was finally obtained which showed no depression in melting point on admixture with a pure sample of mono-oxy-conessine-hydro-iodide (m.p. 352° C., decomp.). The base from the iodide as well as the hydrochloride, chloroplatinate, and picrate showed the same melting points as those recorded for mono-oxy-conessine and its corresponding salts and no depression was noted in their respective mixed melting points.

Reduction of Di-oxy-conessine to iso-conessine with HI and Red Phosphorus. For the preparation of di-oxy-conessine Warnecke's original method was followed, and from 5.0 gms. of conessine, 4.8 gms. of the di-oxy-product was obtained. Its hydro-iodide, hydrochloride, chloro-platinate and metho-iodide melted at 306° C., 302° C., 257° C. and 311° C. respectively with decomposition. (These salts were prepared by Warnecke but their melting points have not been recorded by him or by any of the subsequent authors who worked with di-oxy-conessine.)

9.0 gms. of di-oxy-conessine was refluxed with 20 c.c. of hydro-iodic acid (*d*, 1.7) and red phosphorus (0.5 gms.) at 125–35° C. for two hours in a metal bath. The filtrate

on cooling deposited a crystalline, colourless product melting at 311°C. with decomposition. On recrystallization from water it separated in colourless, prismatic rods and silky needles melting at 317°C. (decomp.). The base liberated from the hydro-iodide was a pale yellow oil which failed to crystallize from any of the organic solvents. In 1 per cent. alcoholic solution it showed $\left[\alpha\right]_{\text{D}}^{30} =$

$+94.3^{\circ}$ (*iso-conessine* $\left[\alpha\right]_{\text{D}}^{30} = +95.0^{\circ}$).

Its hydro-iodide, hydrochloride, chloroplatinate and picrate also showed the same melting points as the corresponding salts of *iso-conessine* and no depression in their respective mixed melting points could be noted.

Oxidation of iso-conessine with Potassium iodate and Sulphuric Acid.—1 gm. *iso-conessine* ($\left[\alpha\right]_{\text{D}}^{28} = +93.5^{\circ}$), in 15 c.c. of 5 per cent. sulphuric acid was treated with a solution of 0.5 gms. potassium iodate in 15 c.c. of water and the reaction mixture was kept in the cold overnight. The liberated iodine was filtered off, the last traces were removed by shaking the aqueous solution with chloroform. The aqueous solution on being made alkaline with ammonia yielded a sticky base which was dissolved in ether. The ethereal solution was washed with water, dried over sod. sulphate and freed from the solvent on the water-path. The residue on being kept with acetone deposits colourless, silky needles (0.05 gms.) melting at 294°C. (decomp.), giving no depression with a pure sample of di-oxy-conessine.

Action of Chromic Acid on Conessine.—4.8 gms. chromic acid was added in small portions to a solution of 7.2 gms. conessine in 40 c.c. glacial acetic acid and the mixture was heated on the water bath. When the initially precipitated conessine chromate had dissolved, a solution of 2.0 c.c. of concentrated sulphuric acid in 10 c.c. glacial acetic acid was slowly added to it. The reaction was accelerated with the addition of sulphuric acid and appeared to be complete in about an hour. The resultant greenish solution was made alkaline in the cold with a 50 per cent. solution of potassium hydroxide and the precipitated base was filtered. The filtrate was repeatedly shaken with ether and the residue was taken up in the ethereal extract. The ethereal solution was then

washed with water, dried over sodium sulphate and freed from the solvent on the water-bath. The treacly residue was taken up in petrol ether and the solution kept in the cold, when stars of long, colourless needles, melting at 273°C. (0.3 gms.) separated out. The mother liquor on concentration and keeping in the cold deposited a base melting at $128-35^{\circ}\text{C.}$ The final mother liquor ultimately yielded 1.8 gms. of a base which melted at $119-21^{\circ}\text{C.}$ and gave no depression on admixture with pure conessine.

After a few crystallizations from petrol ether, the crude base referred to above as melting at $128-35^{\circ}\text{C.}$ gave 2.4 gms. of a product melting at $151-53^{\circ}$ which on removal of traces of conessine through its insoluble oxalate, finally yielded pure tetra-dehydro-mono-oxy-conessine melting at $159-60^{\circ}\text{C.}$ The second crude base of the reaction melting at 273°C. gave pure dehydro-di-oxy-conessine (m.p. 288°C.) after repeated crystallizations from alcohol and methanol.

Tetra-dehydro-mono-oxy-conessine, $\text{C}_{24}\text{H}_{36}\text{N}_2\text{O}$.—The base is fairly soluble in petrol ether or acetone in the hot, readily soluble in other organic solvents and crystallizes from acetone in hexagonal prismatic plates, m.p. $159-60^{\circ}\text{C.}$ It gives an instantaneous yellow colour with tetra-nitro-methane in chloroform solution. It dissolves in concentrated sulphuric acid with a light yellow colour which deepens on warming and on dilution with water gives a greenish violet solution which finally changes to violet. In concentrated nitric acid, it dissolves to a nearly colourless solution which turns yellow on warming and on dilution with water becomes pink. In 1 per cent. absolute alcoholic solution it showed $\left[\alpha\right]_{\text{D}}^{16} = 51.1^{\circ}$.

After drying to constant weight at 100°C. in *vacuo* over P_2O_5 , found C, 78.6; H, 10.6; N, 7.5; N-CH_3 , 12.35; $\text{C}_{24}\text{H}_{36}\text{N}_2\text{O}$ requires, C, 78.3; H, 9.8; N, 7.6; N-CH_3 (for three methyls), 12.2; $\text{C}_{24}\text{H}_{38}\text{N}_2\text{O}$ requires C, 77.8; H, 10.2; N, 7.6; N-CH_3 (for three methyls), 12.2 per cent.

Tetra-dehydro-mono-oxy-conessine Hydrochloride, was prepared by bringing the components together in ethereal solution. On recrystallization from a mixture of alcohol, acetone and ether, it separated out in long, pointed, colourless, silky needles which melt with darkening at 277°C. It is easily

soluble in water, alcohol or methanol. Found after drying to constant weight at 100° C. *in vacuo*, over P_2O_5 , Cl, 16.1; $C_{24}H_{36}N_2O \cdot 2HCl$ requires Cl, 16.1 per cent.

Tetra-dehydro-mono-oxy-conessine-hydro-iodide, was obtained by adding a concentrated potassium iodide solution to a solution of the base in dilute acetic acid. It crystallizes from water in long, colourless, silky needles melting at 277-80° C. with decomposition. It is fairly soluble in alcohol, methanol or water in the hot, sparingly so in the cold.

Tetra-dehydro-mono-oxy-conessine-chloro-platinate, separates out in orange-coloured cauliflowerlike aggregates of prisms when a solution of platonic chloride was added to an aqueous solution of the hydrochloride. It darkens in colour at 230° C. and melts at 234° C. with decomposition. After drying to constant weight at 100° C. *in vacuo* over P_2O_5 , found Pt, 25.1; $C_{24}H_{36}N_2O \cdot H_2PtCl_6$ requires Pt, 25.0 per cent.

Tetra-dehydro-mono-oxy-conessine-hydro-bromide, was prepared by dissolving the base in alcoholic-HBr and precipitation with ether. On crystallization from alcohol, acetone ether mixture, it was obtained in aggregates of long, colourless, silky needles melting at 282° C. with darkening in colour.

The *picrate* was obtained by adding aqueous picric acid to an aqueous solution of the base hydrochloride, as a yellow crystalline powder, sparingly soluble in water, alcohol or methanol and melting at 225° C.

Bromination of tetra-dehydro-mono-oxy-conessine-hydro-bromide.—On direct titration of 0.3762 gms. of the hydrobromide in glacial acetic acid solution against a standard bromine solution under ice cooling and following the titration with starch-KI paper, it was found to take 0.16 gms. of bromine (one double bond requires nearly 0.17 gms. bromine). The yellowish red precipitate formed during the reaction was washed with ether and dried, when it was obtained in the form of a crystalline powder insoluble in cold water but soluble in the hot. The aqueous solution on being made alkaline with sodium hydroxide gave a bromine-free base which was not investigated further.

Dehydro-di-oxy-conessine, $C_{24}H_{40}N_2O_2$.—It is sparingly soluble in petrol ether, ether, acetone or ethyl acetate but fairly soluble in alcohol or methanol in the hot

and crystallizes from these solvents in stars of colourless needles, m.p. 288° C. In 0.5 per cent. alcoholic solution it showed $[\alpha]_D^{17} = -26.0^\circ$. After drying to constant weight at 100° C. *in vacuo* over P_2O_5 , found C, 74.4; H, 10.3; N, 7.4; $N \cdot CH_3$, 11.4; $C_{24}H_{40}N_2O_2$ requires, C, 74.2; H, 10.3; N, 7.2; $N \cdot CH_3$ (for three methyls), 11.6 per cent.

In chloroform solution it failed to give any coloration with tetra-nitro-methane. In concentrated sulphuric acid or nitric acid it dissolves to a colourless solution which turns slightly yellow on warming and fades on subsequent dilution with water.

The *hydro-chloride* was prepared by adding ether to a solution of the base in alcoholic hydrochloric acid. On crystallization from alcohol-acetone-ether it forms colourless, stout, prismatic rods which decompose at 336° C. It is easily soluble in water, alcohol or methanol. Found after drying to constant weight at 100° C. *in vacuo* over P_2O_5 , Cl, 15.0; $C_{24}H_{40}N_2O_2 \cdot 2HCl$ requires Cl, 15.4 per cent.

The *chloro-platinate* separates out in orange coloured tapering rods when an aqueous solution of the hydrochloride was kept in the cold with an aqueous solution of platonic chloride. It begins to darken from 295° C. onwards and melts at 307° C. with blackening and decomposition. Found after drying at 100° C., *in vacuo* over P_2O_5 , Pt, 13.0 per cent.

Dehydro-dioxy-conessine-picrate was prepared by adding an aqueous solution of picric acid to an aqueous solution of the hydrochloride. It is soluble in water, alcohol and methanol in the hot and crystallizes from water in clusters of yellow rhomboids, darkening in colour from 219° C. onwards and melting with decomposition at 245° C.

References

- 1 Siddiqui S. and Vasisht S.K., *J. Sci. Ind. Res.*, 1945, **3**, 559.
- 2 Giemsa and Halberkann, *Arch. Pharm.*, 1918, **256**, 201.
- 3 Siddiqui S. and Sharma V. N., *Proc. Ind. Acad. Sci.*, 1937, **6**, 191.
- 4 Warnecke, *Ber.*, 1886, **19**, 60.
- 5 Siddiqui S. and Sharma V.N., *Proc. Ind. Acad. Sci.*, 1937, **6**, 199.
- 6 Siddiqui S., *Proc. Ind. Acad. Sci.*, 1935, **2**, 426.

STUDIES IN THE CONESSINE SERIES

PART 8—STUDIES IN THE ACTION OF BROMINE ON CONESSINE AND THE CONVERSION OF THE BROMO-DERIVATIVES TO DI-OXY-CONESSINE AND TO MONO-OXY-CONESSINE

By SALIMUZZAMAN SIDDIQUI and SHYAM
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COMPARATIVE studies in the Hoffmann's degradation of conessine and its isomers, discussed in previous communications¹, the oxidation of conessine with various oxidizing agents² and the simultaneous oxidizing and dehydrogenating action of sulphuric acid on conessine³, all point to a high degree of stability of the conessine molecule. On the other hand, dry distillation of conessine or its hydroiodide,⁴ with or without dehydrogenating agents, showed the nitrogen atoms to be extremely unstable to the carbocyclic nucleus of conessine in so far as, in the case of conessine-hydroiodide, they are split off on heating as ammonia, leaving a hydrocarbon conesen, $C_{21}H_{30}$. These two sets of observations indicated that milder methods for the dehydrogenation of conessine or more drastic methods for the dehydrogenation of its oxidation products, in which the nitrogen atoms are more stable to the nucleus, might eventually yield identifiable simpler bases, and it was as a part of this general scheme that the present authors undertook a study of the dehydrogenating action of bromine on conessine. Such an investigation was also of interest for a clarification of the unusual behaviour of the conessine series of bases towards bromine, reported by earlier authors⁵. Thus, Ulrici obtained only a mono-bromo-derivative from the bromination products of conessine and Siddiqui has noted in the case of *iso*-conessine⁶, that HBr, eliminated from the initially formed bromine addition product adds on to the basic nitrogen of a fresh molecule of *iso*-conessine, yielding the hydrobromide salt of *iso*-conessine. From the quantity of *iso*-conessine-hydrobromide, thereby obtained, he further considered it probable that the fresh double bond, produced by the elimination of HBr, preferentially adds on further bromine which is again eliminated

as HBr, till the major quantity of the base is precipitated out as the di-hydrobromide.

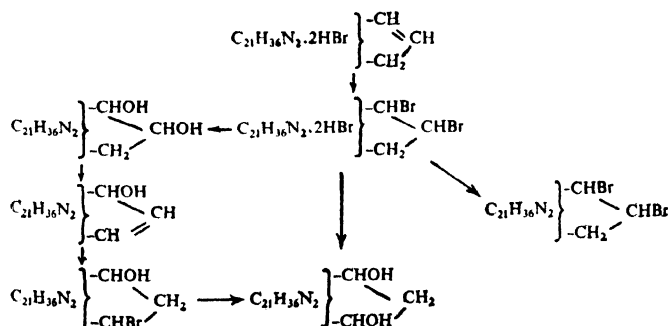
In the present investigations the secondary elimination of HBr and its addition to the basic nitrogen was prevented by substituting conessine-dihydrobromide in place of conessine for the study of this reaction in glacial acetic acid and aqueous medium, whereby di-bromo and tetrabromo-addition products of conessine of which the latter appeared to contain bromine in a loose molecular combination, were obtained.

The dibromo-dihydrobromide of conessine, obtained as a white crystalline powder, on treatment with ammonia or dilute alkali in petrol ether suspension yielded a dibromo-conessine which Ulrici had failed to get by the usual method (*loc. cit.*). An aqueous solution of the dibromo-hydrobromide, however, on treatment with dilute caustic soda gave a mixture of bases which when dissolved in dilute acetic acid and reprecipitated with ammonia yielded a halogen free mono-oxy-base containing a double bond. It has been named as *iso*-monooxy-conessine, $C_{24}H_{40}N_2O$ (m.p. $137^\circ C.$), to differentiate it from the mono-oxyconessine obtained by Siddiqui and Sharma⁷ through the reduction of nitro-conessine. The presence of a double bond in *iso*-monooxy-conessine was shown by its titration against bromine in chloroform solution, whereby the hydrobromide is obtained, as is usual in the conessine series of bases, and by the ease with which the *iso*-monooxy base adds on HBr at the double bond yielding the bromhydrin. The bromhydrin is saturated to bromine in glacial acetic acid solution and appears to partially lose hydrobromic acid on drying in *vacuo* at $100^\circ C.$

When the dibromo-hydrobromide is dissolved in alcoholic or aqueous hydrobromic acid, aqueous hydrochloric or nitric acid

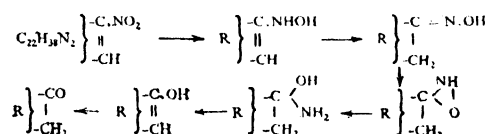
and the base liberated with alkali, a halogen free dioxy-base is obtained whose melting point and other characteristics show it to be identical with the dioxy-conessine obtained by Warnecke and other authors (*loc. cit.*) through the direct oxidation of conessine with iodic acid. The dioxy-base can also be obtained by allowing the aqueous solution of the dibromo-hydrobromide to stand at room temperature for a couple of days and then liberating the base with caustic alkali. This process of conversion is facilitated by treatment of the acetic acid solution of the dibromo-hydrobromide with sodium amalgam. Dioxy-conessine could also be obtained from *iso*-monooxy-conessine by adding caustic alkali to a hydrochloric, hydrobromic or an hydroiodic acid solution (but not acetic acid) of the *iso*-base.

The ease with which the dibromo-conessine-hydrobromide is converted into *iso*-mono-oxy or the dioxy-conessine and the fact that the free dibromo-base can only be obtained by making use of a petrol ether suspension of the hydrobromide, whereby the base passes into the petrol ether layer on liberation, fully establish the extreme susceptibility of dibromo-conessine to hydrolysis. The formation of *iso*-monooxy-conessine, which is due to the loss of a molecule of water from the initially formed di-hydroxy base, its conversion to dioxy-conessine and the stability of the latter, all lend further support to the view held by Siddiqui and Sharma in a preceding communication (*loc. cit.*), that the two hydroxyl groups in dioxy-conessine are not in adjacent positions. The reactions involved in the formation of the bromine addition products and their conversion to the bases mentioned above may be visualized by the following provisional representation :



The position of the double bond assigned for *iso*-monooxy-conessine in the above

formulation also explains the nature of its isomerism to the monooxy-base obtained by Siddiqui and Sharma (*loc. cit.*), in so far as the double bond in *iso*-monooxy-conessine has shifted from the position in which it is present in conessine. In a previous communication⁸ dealing with the conversion of conessine-oxime into monooxy-conessine, Siddiqui and Sharma have brought evidence to show that monooxy-conessine normally exists in the tautomeric keto-form and does not directly absorb bromine.



In *iso*-monooxy-conessine where the double bond is in β - γ position with respect to the carbon carrying the hydroxyl, such a tautomerism is not possible and in conformity with this it has been noted that *iso*-monooxy-conessine readily absorbs two atoms of bromine in chloroform solution.

The tetrabromo-hydrobromide of conessine, slowly loses its bromine on evacuation at 100° C. and thus appeared to be much less stable than the dibromo product. The residue left on removal of the four atoms of bromine was found to be easily soluble in water, but no uniform base could be directly obtained from it. On treatment of an aqueous or a dilute acetic acid solution of the tetrabromo-hydrobromide with caustic alkali dioxy-conessine could be obtained but the yield of the dioxy base was comparatively low.

Addition of two atoms of bromine to an aqueous solution of conessine-hydrobromide gave a colourless solution of the dibromo-hydrobromide, which could conveniently be used for the preparation of *iso*-monooxy or dioxy-conessine, according to the procedure described in the experimental. Addition of four atoms of bromine under identical conditions yielded a yellow tribromo-derivative of conessine which is being further investigated.

Thus while the present investigations have, on the one hand, clarified the complications noted by the earlier

authors (*loc. cit.*) regarding the action of bromine on conessine, they have, on the other hand, opened up an entirely new line of attack for elucidating the constitution of conessine. The addition of two atoms of bromine to *iso*-monooxy-conessine and the technique evolved for the conversion of the bromo-derivative to oxy-products in nearly theoretical yields, is likely to assure success to this line of work, particularly in view of the authors' observation that the zinc distillation of dioxy-conessine gives a petroleum ether soluble base and not a nitrogen-free product as noted in the case of conessine.

Experimental

Action of Bromine on Conessine-hydrobromide

Conessine-hydrobromide (m.p. 340° C.) was obtained as a white crystalline powder by addition of ether to a solution of conessine in alcoholic hydrobromic acid. After drying to constant weight at 100° C. in *vacuo* over P_2O_5 , found Br, 30.5; $C_{24}H_{40}N_2 \cdot 2HBr$ requires Br, 30.9 per cent.

15 gms. of conessine-hydrobromide in 15 c.c. of glacial acetic acid was slowly treated at the ordinary temperature with 37.5 c.c. of a 13.6 per cent. glacial acetic acid solution of bromine (2.2 atoms) with continuous rubbing and shaking. The initial reddish precipitate went into solution during the course of further addition of bromine and towards the end, a white crystalline precipitate consisting of bunches and stars of fine needles separated out, which was filtered, washed with ether and dried on a porous plate (m.p. 235° C. dec.). The bromo-product was finally washed with acetone to remove the coloured impurities when it was obtained in the form of a snow-white crystalline powder (17 gms.) which takes on a yellow colour at 205° C., becomes colourless on further heating and slowly froths, without blackening, from 247° C. onwards. It is completely soluble in water but the aqueous solution deteriorates on evaporation. On drying at 100° C. in *vacuo* there was no loss in weight.

The method described above was arrived at after a great deal of experimentation during the course of which it was found that quick addition of bromine to the conessine-hydrobromide solution very adversely affects the yields of the oxy-bases and that washing of the crude dibromo-hydrobromide is essential to get the oxy-

bases in their maximum yields. Another point of interest noted in this connection was that the treatment of the dibromo-hydrobromide with moist acetone in the hot tends to eliminate both the bromine atoms and thereby yielded back conessine along with dioxy-conessine on liberation of the base from the resultant solution.

Di-bromo-conessine: 4 gms. of dibromo-hydrobromide was suspended in petrol ether and slowly treated with an aqueous solution of liquor ammonia (1:1) and the reaction mixture was thoroughly shaken till the solid had passed into the petrol ether solution. The petrol ether layer was washed with water, dried over sodium sulphate and evaporated to dryness under reduced pressure. The snow-white crystals of di-bromo-conessine obtained on washing the residue with acetone weighed 2.1 gms. (theoretical yield). The dibromo-base could also be obtained by substituting ammonia in the above reaction with dilute caustic alkali.

Dibromo-conessine is sparingly soluble in acetone, easily soluble in ether, petrol ether or alcohol. It crystallizes in clusters of tapering prismatic rods on concentration of its petrol ether solution under reduced pressure. If heated on the waterbath the solution slowly takes colour and a yellowish, sticky treacle separates out. Also on exposure to atmosphere at the room temperature for about two days, dibromo-conessine becomes yellowish and sticky. It can, however, be freed of this yellowish impurity either by washing with acetone or by dissolving out the base in petrol ether. Dibromo-conessine begins to redden from 120° C. onwards, sticks to the sides and swells slowly from $225-32^{\circ}$ C. to a brown spongy mass, which lightens in colour on further heating and melts abruptly with frothing to a brown molten mass at 285° C. On evacuation at 100° C. over P_2O_5 for an hour, there was no change in weight, colour, solubility or melting point. It is saturated to bromine in glacial acetic acid solution. It showed $[\alpha]_D^{32} = -42^{\circ}$ in 1 per cent. chloroform solution. Found in an air-dried sample, Br, 30.65; $C_{24}H_{40}N_2Br_2$ requires Br, 31.0 per cent.

Dibromo-conessine-hydrochloride was obtained as a white crystalline powder on addition of ether to an alcoholic hydrochloric

acid solution of dibromo-conessine. It is soluble in alcohol or water and crystallizes from these solvents in aggregates of hexagonal plates melting at 227-34° C.

Dibromo-conessine-hydrobromide was prepared in a manner similar to that employed in the preparation of the hydrochloride. It is soluble in alcohol and water and crystallizes from these solvents in short fine needles. It froths up at 247-50° C. and undergoes no depression in its melting point on admixture with dibromo-conessine-hydrobromide obtained by addition of bromine to conessine-hydrobromide.

Dibromo-conessine-picrate came out in the form of a bright yellow crystalline powder on adding aqueous picric acid to an aqueous solution of the dibromo-hydrochloride. It is sparingly soluble in alcohol or water and softens from 130° C. onwards, melts at 160-62° C. and froths up with blackening at 195° C.

Dibromo-conessine-chloroplatinate was obtained by adding a 5 per cent. solution of platonic chloride to an aqueous solution of the hydrochloride as a cream-coloured powder which begins to blacken from 228° C. and decomposes with frothing at 235° C.

Iso-monooxy-conessine, $C_{24}H_{40}N_2O$

When an aqueous solution of dibromo-conessine-hydrobromide (0.5 gm.) was made alkaline with caustic alkali, a white crystalline precipitate separated out which after some time became sticky, forming a plastic mass. This was dissolved in dilute acetic acid and the solution was neutralized with ammonia and cooled. A negligible quantity of dirty white precipitate which came out after some time was filtered off. The filtrate was then made alkaline with ammonia and cooled when a voluminous precipitate of silky needles (0.18 gm., m.p. 124-26° C.) separated out. After repeated crystallizations of this crude product from dilute alcohol pure *iso-monooxy-conessine* was finally obtained melting at 137° C.

Iso-monooxy-conessine is soluble in the usual organic solvents and crystallizes from ligroin in long, stout, colourless, prismatic reds. It dissolves in concentrated sulphuric acid to a straw-coloured solution which becomes bright yellow on warming. On dilution with water the colour becomes violet, reddish violet and finally fades away. Fusion

with benzoic anhydride at 200° C. left the base unchanged. In 1 per cent. absolute alcoholic solution, it showed $[\alpha]_D^{35} = +41^\circ$.

Found after drying to constant weight at 50° C. in *vacuo* over P_2O_5 , C, 76.9; H, 10.8; N, 7.2; N-CH₃, 12.6; $C_{24}H_{40}N_2O$ requires C, 77.4; H, 10.8; N, 7.5; N-CH₃ (for three methyls), 12.1 per cent.

Iso-monooxy-conessine-hydrochloride was obtained as a white crystalline powder on addition of ether to a solution of the base in alcoholic hydrochloric acid. On crystallization from alcohol, it came out in the form of silky needles, readily soluble in water or hot alcohol and melting at 273° C. with decomposition. Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 , Cl, 15.9; $C_{24}H_{40}N_2O \cdot 2HCl$ requires Cl, 16.0 per cent.

Iso-monooxy-conessine-hydroiodide was prepared by adding pot. iodide to a solution of the base in dilute acetic acid when it crystallized out in stars of needles. The hydroiodide melts with frothing at 295° C., is readily soluble in water, fairly soluble in alcohol and insoluble in other solvents. Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 , I, 39.2; $C_{24}H_{40}N_2O \cdot 2HI$ requires I, 40.4 per cent.

Iso-monooxy-conessine-chloroplatinate was obtained by adding a 5 per cent. platonic chloride solution to an aqueous solution of the hydrochloride as a buff coloured precipitate. The filtrate deposited aggregates of prisms on being kept in the cold. When freshly precipitated, the chloroplatinate is fairly soluble in water and alcohol but becomes insoluble on drying. It blackens from 229° C. onwards and decomposes at 236° C. Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 , Pt, 25.35; $C_{24}H_{40}N_2O \cdot H_2PtCl_6$ requires Pt, 25.0 per cent.

Iso-monooxy-conessine-di-methiodide prepared by bringing the components together in ethereal solution and allowing the solution to stand, melts at 258° C. (decomp.). Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 , N-CH₃, 11.55; $C_{24}H_{40}N_2O \cdot 2CH_3I$ requires (for five CH₃), 11.4 per cent.

Bromination of iso-monooxy-conessine: 0.0317 gm. of the base was titrated against bromine in chloroform solution under ice

cooling. Following the titration with starch iodide paper it took 0.0144 gm. of bromine as against 0.0136 gm. required for one double bond. A white crystalline precipitate separated out during the reaction which frothed up at 266° C. after previous softening and darkening.

Iso-monooxy-conessine-bromhydrin: A solution of the base in alcoholic hydrobromic acid on treatment with ether gave a white crystalline precipitate which on recrystallization from a mixture of alcohol, acetone and ether came out in stars of needles, m.p. 214° C. It is soluble in alcohol or water and does not absorb bromine in glacial acetic acid solution. Found after drying to constant weight at 100° C. in *vacuo* over P_2O_5 , Br, 35.5; $C_{24}H_{41}N_2OBr$. 2HBr requires Br, 39.0; $C_{24}H_{40}N_2O \cdot 2HBr$ requires Br, 30.0 per cent.

Dioxy-conessine

0.5 gms. of the dibromo-hydrobromide was dissolved in a solution of hydrobromic acid in alcohol and treated with aqueous caustic soda when a white crystalline precipitate was obtained, which after a few crystallizations from alcohol, gave pure dioxy-conessine in a nearly theoretical yield. The melting point, analytical data, as well as the optical rotation of the base and its salts were identical with those of dioxy-conessine (prepared by Warnecke's method) and its corresponding salts and no depression in the respective mixed melting points was noted.

Dioxy-conessine could also be obtained from dibromo-conessine-hydrobromide by treatment of the dibromo-salt in dilute acetic acid solution with sodium amalgam and liberation of the base with caustic alkali, or by allowing an aqueous solution of the dibromo-hydrobromide to stand for 24 hours and subsequent addition of alkali. A solution of *iso-monooxy* conessine in hydrochloric, hydrobromic or hydroiodic acid on being made alkaline with aqueous caustic soda also yielded dioxy-conessine but a solution of the *iso-monooxy*-base in dilute acetic acid gave the unchanged base.

Preparation of Tetrabromo-conessine-hydrobromide

To a solution of 2 gms. conessine-hydrobromide in 3 c.c. glacial acetic acid, a solution of 18 per cent. bromine (6.5 c.c., equivalent to 4.3 atoms) was slowly added under constant shaking. The crystalline

precipitate thereby obtained was filtered under suction, washed with ethyl acetate and ether and was obtained as a light, crystalline, yellowish powder insoluble in water. It slowly loses bromine on evacuation at 100° C., begins to redden and shrink at 155° C., froths slowly from 201° C. onwards and abruptly decomposes at 240° C. Found in an air-dried sample, Br 56.5; $C_{24}H_{40}N_2Br_4 \cdot 2HBr$ requires Br 57.3 per cent.

On heating for 5-10 minutes in water, the tetrabromo-product went completely into solution. The aqueous solution yielded exclusively dioxy-conessine on treatment with alkali. The yield of the dioxy-base from the tetrabromo-salt by this method, or by any other employed in case of dibromo-conessine-hydrobromide, did not compare well with the yields obtained from the di-bromo-salt.

Action of Bromine on Conessine-hydrobromide in Aqueous Solution

To a well cooled solution of 2 gms. conessine-hydrobromide in about 20 c.c. of water, 30 c.c. of a 2.3 per cent. of an aqueous solution of bromine was slowly added. The filtrate from a small quantity of the precipitate which settled down, behaved in its reaction like an aqueous solution of dibromo-conessine-hydrobromide. Addition of 4.4 atoms of bromine to one molecule of conessine-hydrobromide in this experiment, gave a fine yellow precipitate which was coagulated by addition of solid potassium bromide to the reaction mixture. The filtrate gave a further deposit of stars of closely packed short yellow needles which softened at 122° C. and froth at 124° C. Found in an air-dried sample, Br 51.0; $C_{24}H_{39}N_2Br_3 \cdot 2HBr$. requires Br 52.7 per cent.

References

1. Siddiqui, S., Siddiqui, R. H., and Vasisht, S. K., *Proc. Ind. Acad. Sci.*, 1936, **4**, 283.
2. Siddiqui S., and Sharma, V. N., *J. Sci. Ind. Res.*, 1946, **4**, 435.
3. Siddiqui, S., and Vasisht, S. K., *Jour. Sci. Ind. Res.*, 1945, **3**, 559.
4. Siddiqui and Sharma, V. N., *Proc. Ind. Acad. Sci.*, 1937, **6**, 191.
5. Ulrici, *Arch. Pharm.*, 1918, **256**, 57.
6. Siddiqui, S., *Proc. Ind. Acad. Sci.*, 1935, **2**, 426.
7. Siddiqui, S. and Sharma, V. N., *Proc. Ind. Acad. Sci.*, 1937, **6**, 199.
8. Siddiqui, S., and Sharma, V. N., *Proc. Ind. Acad. Sci.*, 1939, **10**, 417.

MANUFACTURE OF PRUSSIAN BLUE

By D. K. JAIN

(D. C. M. Chemical Works, Delhi)

THE war has given a fillip to many new industries in India ; among them may be mentioned the manufacture of Prussian Blue which is an important and essential pigment for many ancillary industries. A manufacturing technique has been developed on a pilot plant scale and its commercial feasibility has been tested.

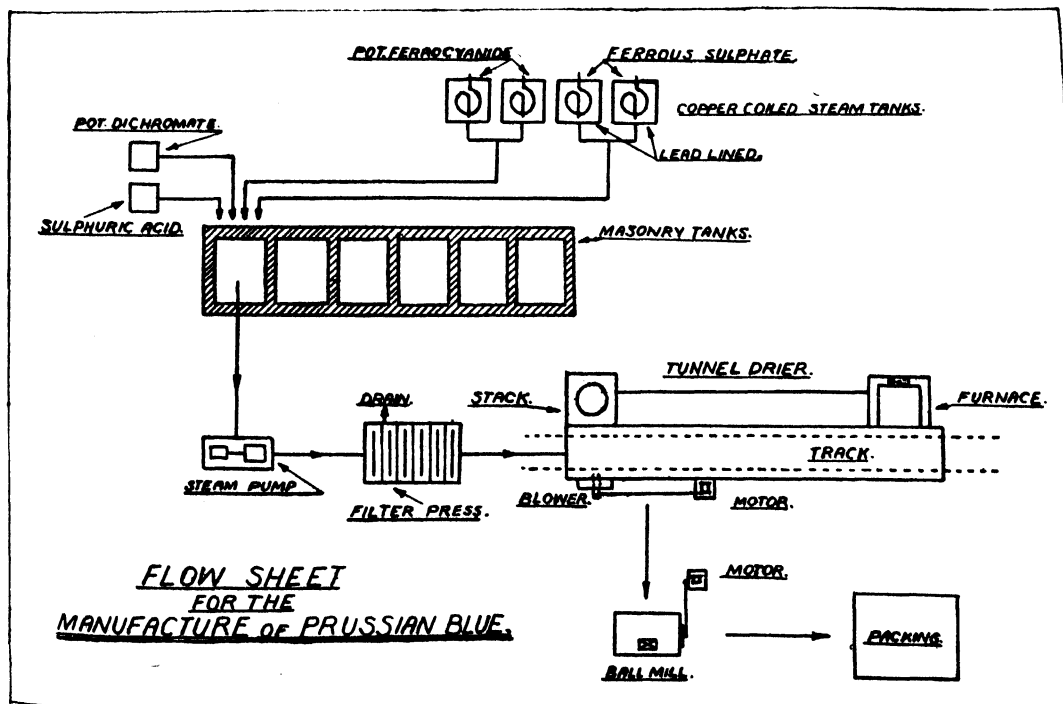
Pilot Plant

A small unit designed and operated for the production of 112 lbs. finished Prussian blue per day of eight hours incorporates the following :—

- (i) 4 steam coiled tanks, two of them lead-lined ;
- (ii) 6 cement tanks ;
- (iii) 1 filter press, plate and frame type ;
- (iv) 1 Duplex steam pump for (iii) ;
- (v) 1 tunnel drier—air blast type ; and
- (vi) 1 ball mill.

The process, which has given satisfactory results, is described below :

Ferrous sulphate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) is dissolved in water in the lead-lined steam tanks to give a 10 per cent. solution. To this is added 1.5 per cent. (on the weight of the ferrous sulphate), of sulphuric acid ($d. 1.750$) to keep it in the green condition. Potassium ferrocyanide ($\text{K}_4\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$) is dissolved in water in the other two unlined steam tanks, also to a strength of 10 per cent. By operating the steam valves, the temperature of the solutions is raised to 85°C. and 95°C. respectively. The ferrous sulphate solution is first dumped into one of the masonry tanks below and during the process of transfer, it is filtered through fine muslin. The potassium ferrocyanide solution is next let down and similarly filtered. During the addition of the latter, the contents of the masonry tanks are vigorously agitated. As a result, a pale bluish-white precipitate (which exhibits a marked tendency to get oxidized by the atmospheric oxygen to a dark shade on the surface) of the approximate composition



$\text{Fe}_2\text{Fe}(\text{CN})_6$ is formed. This is allowed to settle overnight. The supernatant liquid containing sulphates is then decanted and boiling water prepared in the steam tanks above is added to fill up the cement tank. After ten hours the supernatant liquid containing most of the sulphates is decanted off. It will be noticed that the pale coloured precipitate will have settled much faster this time. The precipitate is next oxidized with a hot solution of potassium dichromate and concentrated sulphuric acid. The lustrous blue precipitate is subsequently pumped through the filter press after washing thrice by decantation with water. The filtration is the most difficult operation in the manufacture of Prussian blue. As the particles of the pigment are fine, the slurry is not retained on the fabric in the initial stages, and hence the filtrate has to be recycled several times to obtain a clear discharge.

It has been observed by previous workers that the fineness of particle size of Prussian blue necessitates long filtering cycles to secure an appreciable cake. The use of a plate and frame press is preferred¹ to rotary filters of the Oliver or Portland type, as the former delivers a compact cake containing little moisture. In practice, however, it was found that the moisture content under the best operating conditions, and even after steaming, did not go below 40 per cent.

When the press is full, it is steamed and washed by displacement with water till the filtrate is nearly free from residual salts. In practice, it is not possible to free the cakes altogether from salts and a minimum of 1.2 per cent. on the weight of the finished pigment always remains behind. This is allowed by *B.S.I. Specification² No. 283*. The cakes are next transferred to wooden trays which are stacked one above the other on a trolley and shoved into the tunnel drier.

It is stated that the pigmentary properties are best preserved when the temperature in the tunnel does not exceed 55°C . While this is undoubtedly true, it was found that the rate of drying was not linearly proportional to the temperature inside the tunnel but registered a sharp increase with even a moderate increase of temperature. It has been observed that a temperature of 65°C . is not excessive. The tonal value is not impaired appreciably, while the saving in fuel and electric power consumption is considerable. After the cakes have dried, the lumps

are ground to 100 mesh in a ball mill to form the Prussian blue of commerce, and it is in this form that the material is supplied to the market. If fresh ferrous sulphate has been taken and scrupulous care exercised throughout the manufacturing operation, it will be found that the cakes become sticky and hard. The pigment of this type which breaks with a conchoidal fracture is called "Chinese Blue." This is characterized by a fine metallic sheen and the lumps exhibit a coppery lustre on breaking. The exact methods of making the superior types are a well kept secret and not much literature is available on the processes employed.

Practical Considerations

Oxidation :—Ihne and Kanning³ have stated that the degree of oxidation of ferrous ferrocyanide depends on the oxidizing agent, and that excess of the oxidizing agent has no effect. In our experience whenever an excess of the oxidant was added, a deleterious effect was at once noticed, the resulting product lacking brilliance. Among the oxidizing agents that can be employed are :—

- (a) Atmospheric oxygen ;
- (b) A mixture of sulphuric and nitric acids ;
- (c) Ferric sulphate ;
- (d) Ferric chloride ;
- (e) Chlorine :—
 - (i) Bleaching powder
 - (ii) Aqua regia and
 - (iii) Potassium chlorate and hydrochloric acid ; and
- (f) Potassium dichromate and sulphuric acid.

In an effort to obtain the best product, all the above oxidizing agents were tried in the laboratory, but only (b) and (f) on the semi-commercial scale, as these alone were found to be promising. Spreading of the filtered white precipitate on a glass plate and exposing to air, even for so long as 24 hours, did not turn it into the bronze shade that is essential. Blueing occurred rapidly on the surface and on stirring up, the fresh surfaces were oxidized but the resulting product was not good enough for the trade. Method (b) was somewhat irksome as fumes were given off and safety precautions had to be taken. Moreover, additional steam installation in the precipitation tanks became necessary to ensure

the completion of the reaction. The following procedure was adopted :—

The white precipitate was washed with boiling water and the requisite amount of sulphuric acid was added and the temperature raised to 85° C. The calculated amount of nitric acid was then added in one lot. The temperature fell to 73° C. and steam was again let in to raise the temperature to 88° C. (It was observed that blueing did not occur if the mass was not reheated.) The steam was then reduced. It was found that a number of centres of oxidation separated by about 2 cms. from each other appeared, and reddish nitric oxide fumes began to bubble up from them. Gradually the oxidation extended throughout the mass. After about 8 hours, the reaction was complete and the entire mass turned into a bright indigo blue.

Methods (c) and (d) were also tried. (c) could be adopted commercially but it is cumbersome and ferric sulphate is not easily available in the market. The two methods of making it at the plant itself, namely, (1) oxidation of green vitriol with a mixture of sulphuric and nitric acids, and (2) dissolution of pure ferric oxide in sulphuric acid, are both complicated.

Among the chlorine oxidation methods, the potassium chlorate method is without question the best. It is simple and gives consistent results throughout. The dry product also exhibits the metallic lustre that is so much prized. Under the conditions obtaining in India, however, this process would be too expensive.

In contrast to these methods, (f) is economical, easy of operation and better adapted to small batch production and gives uniform results. It may be mentioned here, that during the manufacture of chromic acid by Zettnow's method⁴, the by-product obtained is potassium acid sulphate contaminated with chromic acid. It was found that a hot solution of this material (at 75° C.) gave excellent tone to the final product. The dichromate equivalent present in the mixture was evaluated by the usual iodine titration and a calculated amount of it used for the oxidation. It would appear that when sulphuric acid and potassium dichromate are used, chromic acid is formed in the intermediate stage but solid chromic acid has apparently a much better effect

on the tone due to its powerful oxidizing nature.

Constitution and Properties

Heaton⁵ has given the formula $KFe^{+++}(CN)_4$. $Fe^{++}(CN)_2$ for an average Prussian blue. He states that combined water is generally present but is difficult to evaluate directly⁶. This is confirmed by Weiser⁷ who from a study of the dehydration isotherms concludes that Prussian blue is not a definite hydrate and does not hold water in definite chemical combination.

The pigment is subjected to partial analysis only, for purposes of evaluation, due to its complex nature. The analytical procedure recommended by Bowles and Hirst⁸ for its complete determination is the standard, but is exacting.

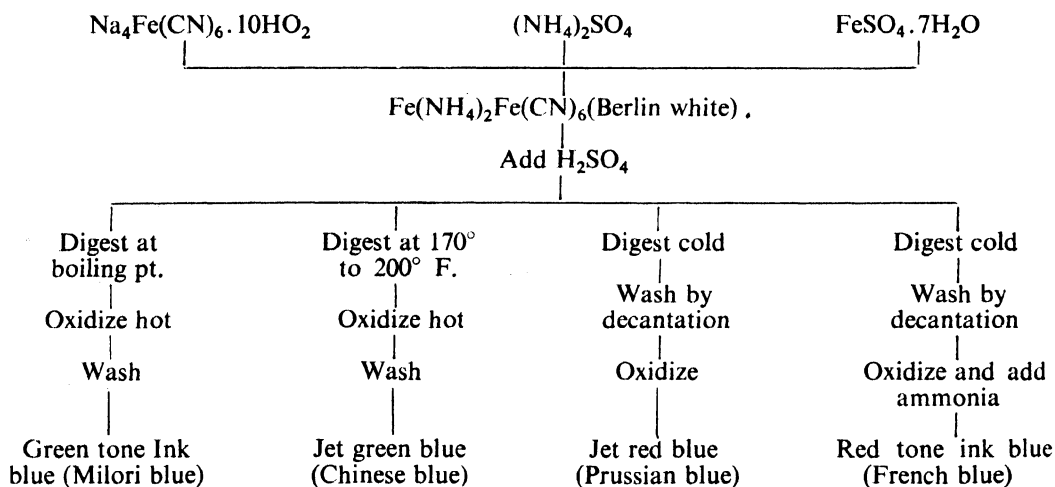
Among the other peculiarities associated with Prussian blue, mention may be made of the following :—

(i) *Hygroscopic nature*⁹.—It was found that stored lumps were very difficult to grind in the ball mill ; they had to be spread out in the tunnel of the drier to make them bone dry before they could be pulverized.

(ii) *Hardness*.—It was observed that the harder the pigment the better was its tone. According to Ernst, *et al*¹⁰, Prussian blue is a gelatinous solid adhering firmly to the drying trays. Heaton¹¹ suggests that due to the slight solubility of the pigment in water, the fine particles tend to form agglomerates on drying, and hence in the dry state the pigment is hard and brittle. It is for this reason that Prussian blue is frequently marketed as an oil paste made by grinding it with a non-drying oil like olive oil on a roll-grinder. With drying oils the pigment exhibits the curious tendency of livering up or leathering¹².

(iii) *Tone characteristics*.—The precautions and care to be taken to realize the finest type of product have been mentioned in the foregoing. While a good type of Chinese blue may be made in this manner, mention is often made in the literature of the presence of stannous chloride ($SnCl_2$), and it is stated that some tin is invariably found in this type of blue which is apparently added as stannous chloride to the ferrous sulphate solution to keep the white precipitate in the ferrous state till the oxidizing agents are added. For the same reason, the fresh water used in the process is often boiled to expel the dissolved air before use.

Williams and Muller¹³ have discussed the factors which affect the bronzing of Prussian blue. Brown's method¹⁴ for obtaining a reddish cast was tried but without positive results. The explanation offered by him, however, seems to be plausible. In a valuable book published recently¹⁵, the different blues tabulated by Brown¹⁶ have been listed. As this table is of interest and the blues have been "named by the shade characteristics as also the names usually associated with these colouring agents and is a step forward in the clarification of nomenclature for these compounds," it is reproduced here.



(iv) *Action of light and heat.*—No satisfactory explanation for the loss of colour which Prussian blue suffers on exposure to light, and its regain in the dark has yet been offered. While this effect is more pronounced in the reduced paints, it was observed that specimen prints made from printing inks containing Prussian blue showed distinct fading on exposure to sunlight for 6 hours.

It is not commonly realized that Prussian blue is a very inflammable substance¹⁷. Indeed great care is necessary, both during drying as well as pulverizing to see that the mass does not catch fire.* The "flash point"—if that word may be used—of Prussian blue, is stated to be 320° F.

(v) *Rate of settling and particle size.*—The particle size of Prussian blue is of the order of 0.8 μ . The rate of settling is naturally

low. Rassudova and Baturkina¹⁹ state that the washing of the precipitate is accelerated if it is suspended in a large amount of hot water. This is substantiated by our own experience. The temperature mentioned by them, viz., 50-55° C. can, however, be raised with profit to 75° C. when it will be found that the rate of settling is greatly accentuated while the tone remains unchanged.

References

1 A. Wright, *Industrial Filtration* (The Chemical Catalog Company, New York), 1923, p. 295.

2 Identical in main respects with *I.S.D. Specification No. G/P-307/27*.

3 Ihne and Kanning, *C.A.*, 1939, **33**, 1202.

4 Zettnow, *Ann*, 1871, **143**, 468.

5 N. Heaton, *Outlines of Paint Technology*, (Charles Griffin & Co., London), 1940, p. 157.

6 *Ibid.*, p. 161.

7 Weiser, *C.A.*, 1941, **35**, 3874.

8 Bowles and Hirst, *J. Oil and Colour Chemists Ass.*, 1926, **9**, 253.

9 N. Heaton, *Outlines of Paint Technology*, p. 161.

10 Ernst, Ardern, Schmied and Tiller, *C.A.*, 1938, **32**, 8843.

11 N. Heaton, *Outlines of Paint Technology*, p. 160.

12 G. Martin, *Industrial Chemistry, part I—Organic* (Crosby Lockwood and Sons, London) 1931, p. 502.

13 Williams and Muller, *C.A.*, 1939, **33**, 9681.

14 Brown, *C.A.*, 1941, **35**, 1249.

15 C. Ellis, *Printing Inks*, (Rheinhold Publishing Corporation, New York), 1940, p. 142.

16 Brown, *American Ink Maker*, 1939, **17**, 23.

17 *Chem. Trade J.*, 1933, **92**, 278; *Rev. P. C. V.*, 1938, **6**, 91, 111.

18 C. Ellis, *Printing Inks*, p. 173.

19 Rassudova and Baturkina, *C.A.*, 1939, **33**, 388.

* When Prussian blue is burnt, ammonia is evolved and ferric oxide (Fe_2O_3) or Prussian brown is left behind.

Letters to the Editor

"CUP ASSAY" METHOD FOR DETERMINING AMYLOLYTIC ACTIVITY

SASTRI and Sreenivasaya¹ (1933) showed that amylase could be detected by "spot" test, and indicated the possibility of determining the comparative potency of diastatic preparations by treating drops of reaction mixtures placed in the depressions of a porcelain test plate, at different intervals of time, with standardized drops of a centinormal iodine and matching the colour with a standard. This method has worked exceedingly well in our hands, in connection with our studies on the fractionation and concentration of fungus diastase, where we had to obtain quickly, a rough estimate of the diastatic activity associated with each of the fractions and follow the degree of concentration achieved at each of the fractionations.

The possibility of adapting the "cup assay" method (developed by Abraham, *et al* (1941)² in connection with their extensive antibiotic investigations) for a quantitative estimation of the amylolytic activity of a large number of fungal and bacterial diastase preparations and their fractions, suggested itself in the course of our studies.

25 c.c. of 0.4 per cent. starch agar media, (saturated with toluene), was plated out in a 4" petri dish; glass cylinders (10 mm. diameter x 12 mm. height) were placed at the centre of the four quadrants of the petri dish. The cylinders were filled with the enzyme preparations saturated with toluene and buffered to the optimum pH. 4.5, and the petri dishes were maintained at a temperature of 37° C. in an incubator. The dishes were flooded with N/100 iodine after 12 or 24 hours as desired; the reagent stains only those portions which have not been acted upon by the enzyme, leaving clear circular zones concentric to the cups, unstained by iodine. The area (A) cleared is calculated from the diameter of the zone and that of the cylinder, both of which are actually measured. The rate of clearance with time for a given concentration of enzyme could be measured by running several cups each being intended for test after a given

interval of time. Results of tests with two different concentrations of the fungus enzyme extract are given in Table I.

TABLE I

Time, hours:	6	12	18	24
Area cleared—Sq. mm. with enzyme (1/50 concentration)	72.0	141.7	513.0	513.0
Do. (1/100 concentration)	0.0	72.0	288.0	288.0

The results reveal a close proportionality between the concentration of the enzyme and the area of clearance. The method can be employed for a comparative estimation of the amylolytic activity of preparations of diastase, especially in industrial laboratories where a simple and reliable method is desired.

B. S. LULLA.
M. SREENIVASAYA.

Section of Fermentation Technology,
Indian Institute of Science,
Bangalore, 7th November 1945.

¹ Sastri B. N., & Sreenivasaya M., *Mikro Chemi.* 1933, **14**, 159.

² Abraham, *et al.*, *Lancet*, 1941, **240**, 177.

CORROSION OF IRON BY WATER-IN-OIL EMULSIONS

WHILE conducting gas purity tests on producer-gas plants and research work connected with it, it was observed that, when a considerable amount of moisture passed along with producer gas into the bench test engine used as a pump, the mineral lubricating oil had a tendency to emulsify a considerable quantity of water producing a water-in-oil type emulsion. This emulsion led to excessive corrosion and rusting of the metal parts of the engine.

It is known that water is not entirely insoluble in petroleum oils¹. Its solubility in transformer oils is of great practical significance. Complete protection against corrosion of a metallic surface coated with oil or grease has never been possible. In these cases, though the oil is supposed to wet the metal surface in preference to water, yet the oil film is not found to be completely impervious to moisture. Experiments on the diffusion of water through oil films of 0.8 to 3 mm. thickness showed that diffusion

takes place readily, due presumably to the solubility of water in oil.

Experiments on the corrosion of highly polished mild steel plates dipped in emulsified oils at 50° C. for 250 hours showed that the corrosion could be effectively stopped by the use of small quantities of certain additives such as fatty acid soaps of chromium. Action of chromium in this case appears not only due to its well-known properties as a corrosion resistant agent for iron, but also due to the retardation of the rate of diffusion of water through the oil film in which its soap is present. This has been established by separate diffusion experiments.

Extended work on the measurements of the rate of diffusion of water through oil films of various thicknesses, with and without additives and also on actual long-term engine trials on lubricants so protected are in progress. Full experimental details, together with the results, will be communicated later.

Physical Laboratories,
Council of Scientific and
Industrial Research, Delhi.
7th November, 1945.

L. C. VERMAN.
M. L. KHANNA.

¹ Evans, E. A., *Lubricating and Allied Oils* (Chapman & Hall Ltd.) 1945, p. 170; Gurwitsch, L., and Moore, H., *Scientific Principles of Petroleum Technology* (Chapman & Hall Ltd.), 1932, p. 263.

PLATINUM IN DHANGAWAN (JUBBULPORE DISTRICT, C.P.) BAUXITE

ABOUT one furlong before the 35th milestone on the Jubbulpore-Katni road on its east side, occur three small hills, bounded by a single contour. On the one nearest to the road is located the Dhangawan bauxite quarry. The base of the hill, which is about 50' high, comes quite close to the road. Sir Cyril Fox has given a brief account of this deposit¹. He has stated that the Dhangawan deposit is nearly half a mile in length, the average width varying from 50' to 100'. The proved depth is roughly 20' and it is estimated that about 100,000 tons of fair quality bauxite occur on the ridge.

Actual working of the deposit for bauxite was recommenced in 1943, when it was being supplied to *Messrs Aluminium Corporation of India*, and *Messrs. Andrew Yule &*

Co. The latter utilize the material for the manufacture of fire-bricks. At the time of the author's visit in January 1944, the production was about 8 tons per day.

Chemical analysis by *General Chemical Co., New York*, of the average material revealed the following chemical composition (I). The average of four analyses given by Sir Cyril Fox is given under II.

	I	II
Al ₂ O ₃	57.01	55.32
TiO ₂	11.70	8.58
Fe ₂ O ₃	2.28	4.77
SiO ₂	0.94	4.12
Loss on Ignition ..	28.31	27.94
Moisture	0.37	..
	<hr/> 100.61	<hr/> 100.73

Associated with the bauxite, platinum, gold and copper are known to occur. Mr. Walter Dutt, who is the Managing Director of *Messrs. Macpherson & Co.*, informed the author that three samples of bauxite analysed in U.S.A were reported to contain 22, 15, and 11 gms. of platinum per ton of the ore. A number of experiments for the detection of platinum were made by Mr. Mool Chand, of the Punjab University. Both spectrographic and chemical methods were employed. Chemical analysis showed the presence of platinum in a concentration of 0.00353 to 0.0039 per cent.

The management of *Messrs. Macpherson & Co.* have installed a stone breaker and a disintegrator to pulverize the bauxite, which is then passed on a concentration table to fractionate the material into (i) heavy, (ii) medium, and (iii) light fractions. Platinum passes into the heavy fraction.

There are a large number of deposits of bauxite in this country. It would be interesting to investigate whether platinum is associated with them and, secondly, whether it can be recovered profitably. It would be also interesting to determine the occurrence of platinum in the parent-rock, which is considered to be the Deccan Trap in this case. It would be desirable to test some of the placer deposits derived from the Trap for the association of any platinum or gold.

Benares Hindu University,
October 30, 1945.

H. L. CHHIBBER.

¹ Cyril Fox., *Mem. Geol. Sur. Ind.*, 1923, 49, 113.



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THE INDIAN SCIENCE CONGRESS, 1946

THE *Indian Science Congress Association* which recently held its annual session at Bangalore, has every reason to congratulate itself on its achievements. The presence at its meetings of large numbers of scientists from all parts of India is an indication of the importance which scientists attach to these annual gatherings and of the interest which scientists take in the expanding activities of the *Association*. Considering that India is a vast country and that opportunities for contacts among working scientists are few, it is hardly surprising that these meetings are looked to with great expectancy. Besides affording a common meeting ground for the widely scattered Indian scientific community, the *Association* exerts an enlightening influence on the public mind. Learned societies take advantage of the assembly of scientists to hold their meetings and conferences. Manufacturers of scientific instruments exhibit their products and bring to the notice of research workers and the public the progress of the instruments industry year after year. The *Association* has been rendering a great service to the cause of scientific advancement in India.

The Bangalore session was a great success judged both by the number of delegates present and the variety of subjects discussed at its scientific meetings. The address of Prof. M. Afzal Husain, the General President, dealt with the food problem of India. It is hardly necessary to mention how very vital and critical the food problem is. A number of

discussions on food production, nutrition and ancillary subjects were organised and a large section of the delegates present took part in them. Stress was laid on the three ways of improving the food supply to a level adequate to meet national requirements. They are firstly to expand the area of cultivation under food crops and adopt scientific methods of crop planning and intensive cultivation, secondly to expand the preservation industries and lastly to fortify the available materials to enhance their nutritional value. The results of scientific research in agriculture and food technology, which have been applied with spectacular success in other countries, have to be adopted in India if the crisis in food supply is to be surmounted.

Although science has supplied the means the results achieved even during these critical years have been disappointing. It is worthwhile considering why this is so. In his address to the Section of Agricultural Sciences of the Indian Science Congress, 1945, Mr. N. V. Joshi pointed out :

"If we compare the conditions of agriculture and the agriculturist in 1890, at the time of Dr. Voelker's report, with those in 1939 just before the war and the time of Sir John Russel's report, what do we find ? Do we find any difference attributable to improvements suggested by the agricultural, the veterinary or the co-operative departments of the Government which were started and meant for bettering the lot of

the agriculturist by introducing improved seed, implements and agricultural practices as well as better credit? The description given of the agriculturist as illiterate, ignorant, indebted and poor in 1890 still holds good. It appears to fit in for both the periods. While the crop yields from improved seeds and the milk yields of improved cattle breeds on experimental farms are high, the general level of agricultural and milk yields does not appear to have increased. In what way then have we benefited the agriculturist or the agricultural business during all this period of fifty years from 1890 to 1940, a period during which the research workers in agricultural sciences have accomplished remarkable results which are held by scientists to be of great practical utility? Since we have not benefited the cultivators, it may be concluded that somehow we have failed to convey the information about the results of agricultural research and improvements to the proper quarters or to get them adopted in their common practice by the cultivators."

In contrast to this deplorable situation in India, the results achieved in Britain are truly spectacular. Says the Rt. Hon'ble Lord Woolton in this connection*:

"Scientific research applied to agriculture was making it possible for Britain's farmers to increase the yield of the land beyond the most hopeful public expectations. Now in the sixth winter of the war the great 'combined operation' which the food front represents and in which the scientist has played such a conspicuous part, finds our standards of health well maintained, and in many ways actually improved, in spite of the stresses and the hazards of war and it finds British agriculture becoming a mechanised science and serving a great national purpose."

The results obtained in Great Britain have been attributed to the public support which the measures adopted by the Ministry of Food have received. The public could appreciate the policy of the Ministry and accept the measures based on the knowledge and standards which science had made available. The credit for this result has been rightly attributed to the work of the *British Association for the Advancement of Science*. Here is Lord Woolton's testimony to its work.

"The *British Association* may take credit for what it did to prepare the public mind for this approach. Year after year, beginning with the Presidency of the father of the science of nutrition, Sir Gowland Hopkins, at Leicester in 1933, and followed by the discussion on the social implications of nutrition in 1934 at Aberdeen and the great debate on its relation to agriculture and human needs at Norwich in 1935, the *British Association* hammered home the facts. People were made to realize that nutrition, far from being a fad, was simply the plainest of commonsense . . ."

We have quoted at length from Lord Woolton's address in order to indicate the importance of educating the public, and the impressive part which the *British Association* has played in the diffusion of knowledge. The position in India, unfortunately, is that the advancement of scientific knowledge hardly arouses any enthusiasm. There is little appreciation of the important fact which was dimly recognized for many years, but which was brought into high relief by the war, that at the material level science is a public necessity, and without deliberate utilization of science by society, progress cannot be achieved. The community at large must become science-minded. In the task of educating the public and rendering it receptive to progressive scientific measures, the *Indian Science Congress Association*, whose aims are analogous to those of the *British Association*, has a great mission to fulfil.

* *The Advancement of Science*, 1945, 3, 143.

STANDARDS OF LENGTH

By B. L. GULATEE

(Survey of India, Dehra Dun)

BEFORE industry can develop in any country to the fullest extent, it is essential that facilities should be available for rapid and accurate comparisons of various dimensions against accepted standards of length. All advanced countries have organizations of their own for specifying industrial and primary standards, and are fully equipped for standardizing them within the limits of tolerances required for various purposes.

India at the moment is passing through an era of industrial awakening, and a scheme has been initiated by the *Council of Scientific and Industrial Research* to start a National Physical Laboratory for India. Several articles have appeared lately urging the need for a Central Bureau of Standards and describing the standardizing institutions in other countries¹. Such institutions have varied activities, but we shall review in this article, only the position as regards standards of length in use in the world in general, and in India in particular. It is hoped that this will help in appreciating what is involved and what needs accomplishing.

British and Metric Standards

The legal British and metric standards are the yard and the metre. The Imperial standard yard is a solid bronze rod of square cross section cast in 1845, its length being defined as the distance at 62° F. between fine lines cut on gold plugs near its extremities. It is preserved in the Standards Department of the *Board of Trade, Westminster*.

Several authentic copies of this have been prepared to serve as secondary standards and these are compared against the primary yard only after a number of years.

The metre is defined as the distance at 0° C. between centres of two lines graduated on a bar of platinum-iridium alloy. It is deposited at the *Bureau Internationale des Poids et Mesures, Sevres, Paris*. Like the Imperial yard, this bar is also preserved carefully and all work is done with accurately prepared copies.

Being material standards, they both suffer from the disadvantage that they can undergo unknown secular changes of length with

lapse of time, and in case they get destroyed or lost, it would be difficult to reproduce them. This latter difficulty was realized, and when the Imperial yard was first passed by an *Act of Parliament* in 1824, it was laid down that in case of loss or destruction, yard length should be redetermined by reference to the length of a pendulum vibrating seconds of mean time in a vacuum at 62° F. in latitude of Greenwich at sea level. At a later date, as it happened, this standard yard was actually destroyed by fire, but it proved to be impracticable to restore its length in the above way with sufficient accuracy. It was actually reproduced by reference to its existing copies. It should be noted that keeping of authentic copies is by no means a solution of the problem, because these latter are also impermanent and are subject to varying changes.

On the continent of Europe, the first geodetic unit of length was the French "Toise of Peru", an end bar constructed in 1735. Copies of this toise were sent to Russia in 1821, to Prussia in 1823 and to Belgium in 1852, to serve as basis of measures. These toises were intercompared at various times and are described in Clarke's *Comparison of Standards of Length*, 1866. During the French Revolution, a Committee of the *French Academy* proposed the introduction of a new standard of length, viz., the Metre. They recommended that it should be made exactly equal to 1/10 million part of the earth's quadrant passing through Paris. It was thought that with the help of this definition, it would be possible to reproduce it at any time in case of accident. An arc of the meridian was accordingly measured for the purpose of realizing this standard, and based on this measurement, the French Law fixed the relation of metre to toise as 1 metre = 0.513,0740 Toises. This metre, known as the Legal Metre, was, however, not materialized in the form of a bar, and instead of perpetuating it by some tangible means, they made new copies of the toise as described above and supplied it to the various nations of Europe, the idea being that they could be converted to metres by the conversion ratio. Later on, it was realized

that the "Toise of Peru" was a defective standard as its ends were slightly damaged and the *French Academy* ordered Borda to construct improved standards. He made four "Rules"—bimetallic rods of copper and platinum—and standardized them with meticulous care against the "Toise of Peru" at 13° R. He also constructed, in 1795, a platinum metre bar called the "Metre of Archives." He made it as best as he could according to the legal definition, but did not calibrate it in terms of the toise, as it was intended to replace the toise by one of the four "Rules", called the "Module", as a standard of length. The module, and the various copies of the toise were in use till 1873, when at an international conference it was decided to adopt the "Metre of Archives" as the Standard Metre. It was labelled as the prototype International Metre and several copies were prepared and standardized against it and issued to the various nations. The fact that it had never been compared against either the toise or the module was overlooked. This involved a fundamental confusion of thought. Before superseding the module, the proper course would have been to compare this antique bar carefully against the toise or the module. As it is, considerable uncertainty remains in relating the International Metre to the toise. Details of this are described later. Suffice it to record here, that the original attempt of the French scientists to produce a perfect standard related to the terrestrial dimensions actually proved unsuccessful. The metre does not approximate sufficiently closely to 1/10 million part of the earth's quadrant but differs by 230 parts in a million from it, and is not in a better position than the Imperial yard from the point of view of ready reproduction in case of loss.

Standards of Length in India

Indian Legislation by the Measures of Length Act II of 1889 prescribed that "The Imperial Standard Yard for the United Kingdom shall be the legal standard of length in British India and be called the standard yard." In pursuance of this *Act*, a copy of standard yard was obtained from the Secretary of State for India in 1888 and deposited at the *Mathematical Instrument Office*, Calcutta. This office has since manufactured certified copies of this yard on demand, but these have so far been used only to check the crudely made yards of commerce.

The Survey of India for its mapping and geodetic work had to choose a unit of length much before the above *Act* was brought into force. The measurement of accurate base-lines (6 to 10 miles long) forms an integral part of a primary land survey. These base-lines form sides of triangles and are introduced at suitable intervals in a triangulation network for controlling the scale error.

The earliest base-lines in India were measured between 1880 and 1826 by the pioneers of the *Survey of India*, Lambton and Everest. They had at their disposal only a 100-foot steel chain, now preserved at the *Survey of India Museum*. They correctly realized that the chain, even at its best, was a precarious form of standard, and would not do for the precise framework of India, which they had in mind. In 1830, Everest² brought into India 6 Colby Compensation bars, and two standard bars A and B after comparing them against British standards in England. With these bars 10 base-lines were measured with considerable accuracy between 1832 and 1869. The earlier bases measured with the chain were rejected.*

Although the compensation bar apparatus was far superior to the chain which it superseded, measurement of base-lines with these bars was a very slow and difficult procedure, the rate of progress being less than 200 yards per day.

In 1896, an alloy of nickel and steel called *invar* was discovered by Dr. Guillaume of the *Bureau Internationale des Poids et Mesures*. This had a smaller coefficient of expansion than any other metal or alloy so far known. A method was proposed by Jäderin for precise base measurements with the help of wires of this alloy suspended in catenary under a constant tension. This marked a great advance over the older technique and admitted of base-line measures being carried out much more expeditiously and with high precision. In the beginning of this century, with the extension of triangulation network of India, the need for some more base-lines was felt, and with commendable foresight, the *Survey of India* obtained better standards of length and a modern base measuring gear. This latter comprised a set of nine invar

* The same state of affairs occurred in Germany as well, where the older base-lines were measured with Bessel's bimetallic rod made of zinc and iron. Zinc seemed to have behaved peculiarly and all their earlier base-lines had to be remeasured.

wires of 24 m length, standardized at the *International Bureau* at Sevres in 1908 and received in India in 1914. Seven new bases have been measured in India with this apparatus between 1930 and 1934.

For the standardization of these wires, 1-metre nickel, 1-metre nickel steel and 1-metre invar bars of modern construction were also acquired from the *Societe Genevoise of Geneva* in about 1914 on the advice of the leading metrologists of the time. Later on, these were supplemented by a 1-metre fused silica bar, constructed by the *National Physical Laboratory, England*, and standardized by them in 1925 and then again in 1931. It is a hollow tube with flat end slabs, the undersides of which are platinized, the defining lines being ruled on these slabs in the neutral plane.

In addition, a 4-metre nickel-steel and a 4-metre invar bar were also obtained to be used as connecting links between 1-metre bars and 24-metre wires. The original intention was, that 1-metre nickel would be the fundamental standard, as it was considered to be the most stable, but experience has shown that fused silica is more stable than it.

Secular Changes of Standards

Experience shows that all material bars, no matter how carefully handled and preserved, undergo gradual variations with time called secular variations. This is particularly true of older standards, constructed at a time when knowledge about stable metals and alloys was meagre. Thus, the Imperial Standard Yard made of bronze has not been stable and doubts have been expressed that its present length may be as much as 5 in 10^6 different than when it was first cast, which is a very large amount from the point of view of precise metrology. Similarly, the old *Survey of India* Standard Bar A made of iron has shown wide discrepancies when compared with other standards at different times. Considerable research has been carried out for the discovery of stable metals and alloys. The present practice is, that the primary standard is made of very stable and costly material and working copies of it in invar and other metals are supplied for practical purposes. Invar, in particular, has a negligible coefficient of expansion but is molecularly unstable, and bars of this metal exhibit progressive changes in length of as much as 0.5 in 10^6 per year.

The invar wires with which the bases are measured are, of course, very much more fragile, and often show sudden and inexplicable changes. Even winding and unwinding on their drums in the course of base measurement can affect their lengths by significant amounts. They have been found to change by as much as 10 parts in 10^6 during the course of a base measurement. This is a much larger amount than the actual error of measurement with these wires. Hence, although the laboratory certificates of their lengths are given to 1 in 10^6 at a specific temperature, the wires are not capable of holding this length for long. Their coefficient of expansion also needs checking from time to time.

In view of the above, it is imperative that the working bars should be intercompared periodically and against the primary standard after a number of years, and that the wires should be re-standardized before and after each base measurement. This is done at the *Survey of India*, Dehra Dun, with the help of two very fine pieces of apparatus, called the 4-metre and 24-metre comparators designed by Sir David Gill. These are fully described in *Engineering*, Vol. 100, 1915.

Some remarks about the accuracy desired of a geodetic base may be added here. The base-lines are measured with four working wires, the first measurement being made with two wires simultaneously and the second in the reverse direction with the other two wires. So far as the standardization of the wires goes, the target is that the mean length of each pair should be known to an accuracy of 2 in 10^6 . Aiming for higher accuracy is wasted labour, as it is soon lost in the base extension system and subsequent figures. The comparators can yield the above accuracy comfortably and more with skilled observations. The field measures are executed with great care so as to keep the various systematic and accidental errors to a minimum. The probable error of base measurement with the older apparatus of compensated bars has been estimated as ± 2.6 in 10^6 and of the modern equipment as ± 1 in 10^6 . It might be mentioned that the work with the comparators in the *Survey of India* has been limited entirely to its own internal needs for programmes of topographical and geodetic surveys, but there is no doubt that it can be made to serve wider fields with more refined technique.

The question of engineering standards of length has a different aspect altogether. For this purpose, the metre and the inch are inconvenient lengths, and it is essential to have a series of accurate sub-divisions of feet and metre in the form of length gauges, slip gauges, cylindrical gauges, etc., as also delicate comparators to enable these gauges to be checked against the primary length standards.

All the above rests on the assumption that the parent reference standards are invariable. With the steady progress in precision in all directions (Mechanical Engineering, Surveying, etc.), a stage has been reached when the uncertainty of change in the primary standard (in spite of its being very small) cannot be tolerated as it exceeds the limit of measurement. It is essential to re-define the length standards in terms of an unimpeachable standard based on a physical phenomenon with absolutely assured permanence. The idea of using wave length of monochromatic light (which remains constant under the same atmospheric conditions) for this purpose was put forward in 1864, but it was not till 1892-93 that Prof. A. A. Michelson³ successfully measured the metre at *Bureau Internationale des Sevrès*, in terms of wave length of light. He used a number of *étalons* (consisting of two plates of optically flat glass, maintained parallel to each other by a ring of brass) and designed an interferometer to count the number of wave lengths in each *étalon*. These *étalons* were then intercompared and calibrated in terms of the standard metre. Since that time, several countries (France, Germany, Japan and England) have made accurate measurements of their national copies of metre in terms of red lines of cadmium. Results on the whole are in fair agreement, the disparities being rendered complicated by the fact that apart from experimental errors, they are burdened with the errors of initial comparison of national standards with the standards at *Bureau Internationale des Sevrès*. At the Seventh International Conference on Weights and Measures held in 1927 at Paris, it was agreed to recommend that the length of metre should be defined as 1,553,164.13 wave lengths of red cadmium light. More work is, however, required in this direction and once international accord has been reached on the length of the Imperial yard and prototype metre in terms of wave length of light, and methods are developed for getting

any standard in terms of these wave lengths, then the need for treating the primary bars as sacrosanct would disappear. This is an intricate task of some magnitude, and would involve intercomparison of National Standards of all countries to unravel the errors of their initial standardizations as a first preliminary.

Foot-Metre Ratio

Before the relation between foot and metre can be defined, we have to be clear about their exact specifications. As already mentioned, the first definition of metre was fixed by French Law in 1792 in terms of their material standard, the Toise of Peru as 1 Metre=0.513,0740 Toises. This is the legal metre, of which no material copies have ever been made, i.e., it has always remained theoretical. Clarke was the first person to obtain the ratio legal metre/yard in 1866⁴. He was forced to do it, as in his days, the whole of Europe used toises for expressing their triangulation lengths, while England used feet. To derive the figure of the earth, from the measured arcs in various countries, he had to relate various European toises to British feet. He carried out elaborate comparisons of the several continental toises against the copy y_{55} of the Standard Yard and by laborious research concluded that 1 toise=6.394,53348 ft. Using the legal ratio of metre to toise as given above, he obtained 1 Legal Metre=3.28086933 British feet. This ratio is obviously burdened with initial errors of comparisons of the continental toises against the "Toise of Peru." It has been mentioned before, how in 1873, seven years after Clarke had produced the above ratio, the International Metre was constructed as a copy of an old standard—"Metre of Archives"—of 1795. In 1889, at an international conference, a number of countries agreed to adopt this metre as their standard of length and, in due course, accurately certified copies of this metre were sent to the various countries to serve as national prototypes.

As explained before, the International Metre was not compared against the toise directly at the time of its inception (1873). Comparisons in later years against toise and yard afford means of relating the legal metre to the International Metre and show large discrepancies. Thus, in 1891, Benoit⁵ compared Bessel's toise (whose value in terms of legal metre was known) with the International

Metre and found the difference between the two metres to be 1 in 76,000. In 1894, Benoit and Chaney compared the International Metre against the British Yard. This provides an indirect means of relating the two forms of metre on the assumption that the Imperial yard suffered no change of length between 1865 and 1894. This comparison reveals the difference to be only 8 in 10^6 . It should be manifest from the above, that the introduction of the International Metre as a unit of measure without properly defining it in terms of the existing measures of length was indefensible, as it introduces an element of uncertainty in bringing the older and modern triangulations of France, Belgium, Russia and Prussia in the same terms.

We have so far been considering the two varieties of the metre. What complicates the situation further, is that the foot is also of several kinds, e.g., the British foot, the Indian foot, the American foot, the Cape foot and so on. The next problem is to interrelate each of these feet to the various kinds of metres. To get a clear grasp of the situation, it would be advisable to give a description of the feet of some countries.

British Foot.—The following relations between the metre and British foot have been derived at various times. Due to their being incommensurable, their comparison has always been a difficult problem:

Clarke (1865), 1 metre = 39.370432 in. . . (i)

Arago and Kater (1878),
1 metre = 39.37079 in. . . (ii)

Benoit and Chaney (1894),
1 metre = 39.370113 in. . . (iii)

Sears (1926), 1 metre = 39.370147 in. . . (iv)

The discrepancies in the various results are by no means negligible. Clarke's ratio relates the legal metre to the British inch and is really not comparable with the others, which appertain to the International Metre.

Ratio (ii) was adopted in 1878 in the United Kingdom. In 1898, this ratio was superseded and an Order of Council was issued legalizing Benoit and Chaney's ratio, although Sears' ratio is believed to be the more reliable one. The difference between the two latter is, however, within the experimental errors of observation.

Indian Foot.—The lengths of the sides of the triangulation in India are expressed in Indian feet, which are defined as one-tenth of the distance between two platinum dots

on Standard Bar A at 62° F. This iron bar, made over a century ago, was used for the standardization of compensated bars employed for base measurements between 1831 and 1882 in the older triangulation of India. It is obsolete now and since 1930, a number of base-lines measured in metric terms have been incorporated in the new triangulation network. To be able to bring the latter in sympathy with the older triangulation, and also in order to be able to connect the Indian triangulation with that of adjoining countries, it is essential to evaluate bar A in terms of International Metre and British feet.

The first comparison of this bar was made in 1834-35 in India against a sister bar B which had been compared with Ordnance Survey 10-foot standard O₂ in London in 1832.

The sub-standard B was sent to England in 1843 and was included by Clarke in his 1865 comparisons of toise and metre. Bar A was recompared against it in 1867, and a discrepancy from the former result amounting to 5 in 10^6 was obtained. The 1835 comparisons were considered to be suspect, and were rejected.

1865-67 comparisons gave A, as 3.333,318,86 British yards at 62° F. or 1 Indian foot = 1—0.000,004,342 British feet, implying that an Indian foot is shorter than the British foot by 4 in 10^6 . In 1907, bar A was carefully compared with the International Metre at Pavillon Breteuil at Sevres, and using the conversion ratio the result obtained was A = 3.333,332 British yards, differing by 4 in 10^6 from the previous value. This difference may well be due to a change in the length of bar A between 1865 and 1907, as it was considered obsolete and was not carefully preserved after 1880.

To get the Indian foot in terms of the International Metre, we have no alternative but to make use of British foot to International Metre ratio as determined by Benoit and Chaney in 1894, or by Sears in 1926, and assuming that the British yard maintained the same length from 1865 to these dates.

American Foot.—In the early days, the U.S. employed the same yard as that of Great Britain, but in 1866 an Act was passed legalizing the metric system in the U.S. and defining yard and metre by the relation

1 metre = 39.37 inches.

A copy (No. 27) of the International Metre has been declared legally as the national prototype of metre. The Americans thus maintain only metric primary standard, and not a prototype copy of Imperial yard. They compute their surveys in metric system and for the convenience of users, print the data both in metres and feet, utilizing the above ratio. Since $1 \text{ metre} = 39.370,113$ British inches, the American inch is longer than the British inch by 2.9 in 10^6 .

It is not the object of this paper to go exhaustively into the varieties of foot employed in different countries, but enough has been said to show how complicated calculations are rendered by the existence of diverse foot-metre ratios and how they can become a pitfall for the unwary. As an example, consider the case of spheroids (Figures of Earth) used for mapping in the various countries. Every country has prepared geodetic tables for its own spheroid. The dimensions of some of these spheroids, such as Everest, are expressed in feet, while those of others such as Clarke and International are in metres. When converting data from one spheroid to another, the foot-metre ratio to be used is always a problem. Thus, Everest spheroid used in India has its semi-major axis.

$a = 20,922,931.8$ Indian feet.

Its value in other units by adopting the ratios quoted above are:—

$a = 6,377,276$ International Metres.

$= 20,922,841$ British feet of 1865-94.

$= 20,922,859$ British feet of 1926.

The U.S., Canada and Mexico employ Clarke's 1866 spheroid as a basis for their geodetic work. Clarke gave dimensions of this spheroid in British feet, as also in metres by his conversion factor of legal metre to foot. The Americans in making geodetic tables have accepted his a in metres as if they were International Metres, and have used their own conversion factor $1 \text{ m} = 39.37 \text{ in.}$ In other words, they are using a modified Clarke's 1866 spheroid.

Similar remarks hold about Clarke's later figure—his 1880 spheroid. He fixed his $a = 20,926,202 \text{ ft.} = 6,378,250$ legal metres. This fact was overlooked when geodetic tables were made by the *Royal Geographical Society* in 1927. These tables are for $a = 6,378,250$ International Metres and when used in a country where base-lines are

measured in International Metres, it should be realized, that Clarke's figure of Earth is not being used but a modified figure which differs by 50 metres from it on account of the difference between Legal and International Metres. While the U.S. practice to keep only metre as the standard and to use a simple conversion ratio $1 \text{ metre} = 39.37 \text{ in.}$ is certainly a step in the right direction, it might be of interest to mention that for several years, in industry, many nations who build machinery in both units have used the ratio $1 \text{ in.} = 25.4 \text{ mm.}$ which differs from the above by 2 in 10^6 . A proposal to unify and simplify the foot-metre ratios was made at the Congress of Associations for Weights and Measures held in New York in April 1926, where a wish was expressed that the basic inch should be changed so that it bears the relation $1 \text{ in.} = 25.4 \text{ mm.}$ This will affect, of course, both the British and American inches and if the proposal is implemented will have hardly any repercussions in land and hydrographic surveys.

Summary

To recapitulate. It is an objection against primary material standards that they do not hold their length indefinitely. It is practically impossible to evaluate accurately some of the older standards (like the Toise or the Standard Bar A of India) at this time on account of their defective design and the unstable material of their construction. With increasing demands for high precision in all directions, a stage has been reached when material standards of length fail to rise to the occasion, their care and design notwithstanding. The position considered in the light of present knowledge is that primary standards should ultimately be defined in terms of wave length of light.

There is at present a considerable diversity in the foot-metre ratio, which is to be deprecated on several grounds, not the least weighty of which is the confusion that is apt to be created in the minds of many. The need for uniformity in this direction is too apparent to need stressing.

International accord has yet to be reached about defining the lengths of standards in terms of wave length of light. This would involve intercomparison of national standards of all countries and their measurement in terms of red radiations of cadmium to the highest precision, a task of no mean magni-

tude. Facilities would have to be provided at each metrological observatory to calibrate each standard correct to the precision adequate for the class of work for which it is intended. Considerable research is required for developing optical interference methods for comparison and measurements of various lengths and gauges. It is desirable that the scientific talent in India should make a start towards contributing to the solution of the above and cognate problems. Adoption of a fixed metre defined in wave lengths of light and of a universal conversion ratio to British units may end the present muddle once and for all, but human nature is always an impediment in affairs of this sort, and it would be too optimistic to expect an immediate move from all countries in this direction.

India has no precise industrial standards, nor is there any central organization responsible for them. There appears to be urgent

need for institutions like the *British Engineering Standards Association (B.E.S.A.)* which is responsible for drafting standardizing specifications in the United Kingdom, the *Board of Trade* which is entrusted with the duty of stressing standardization and simplification and the *National Physical Laboratory, Teddington*, which is equipped with elaborate apparatus and expert staff for carrying out standardization work of every description.

References

- 1 *Science and Culture*, 1944, 10, 137, 139; *J. Sci. Ind. Res.*, 1945, 3, 437.
- 2 *Survey of India, G. T. S.*, 1870, 1, 2.
- 3 A. A. Michelson, *Light Waves and their uses*.
- 4 Capt. A. R. Clarke, *Comparisons of the Standards of Length of England, France, Belgium, etc.*, H. M. S. O., 1866.
- 5 Benoit, *Determination du Rapport du Yard et Metro, Paris*, Gauthier-Villens, 1896.
- 6 *Phil. Trans., Series A*, 1928, 227, 281.

PARTICLE SIZE PROBLEMS IN INDUSTRY

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IN any process involving a physical or chemical reaction between a solid phase and another phase which latter may be either solid, liquid or gaseous, it will be readily recognized that the surface area available for such reaction, which is inversely related to particle size, plays an important part in determining the extent to which the reaction may proceed and its speed of progress. The field of industry covered by such reactions is almost as wide as industry itself, and it would be futile to attempt to catalogue all possible instances in which surface area plays an important part. While it is evident that surface area is closely related to particle size, there are cases in which surface area alone is significant, such as, for example, in catalytic and other chemical reactions, adsorption phenomena and so forth. Furthermore, there are instances where particle size alone is of chief interest such as, for example, in smoke screens, cosmetic powders, abrasives including undesirable abrasive dusts, powder metallurgy, etc. On the other hand, there is a class of phenomena in which both surface area as

well as particle size contribute their share and it is to this class that the following remarks would apply more appropriately. Examples in this class may be cited of concrete mixes, mortars and plasters; china-ware, bricks and refractories; plastic-filler compositions and rubber mixes; carbon electrodes and pencils; paints and enamels; etc.

Broadly speaking, in this class of application, the solid phase is dispersed in a liquid or plastic phase, which latter may be ultimately converted to solid phase. The chemical and physical reactions which take place during the initial stages of dispersion and later stages of conversion, both play an important part in determining the final properties of the aggregate mass. These reactions include both surface reactions taking place between the two phases and those taking place within individual phases. It is the interphase reactions which are largely influenced by the surface area of the particles. But apart from the influence of surface on interphase reactions, the particle size and its distribution also play an impor-

tant role in determining the final properties of the aggregate.

An excellent example of this interplay is furnished by lime-surkhi mortars, a detailed study of which was published some time ago¹. From this study it became clear that the final strength of lime-surkhi mortars could be increased progressively by decreasing the particle size of surkhi and thus making available more and more surface area for reaction between lime and surkhi particles, but there was a definite region of particle size in which the increment was much more marked. On either side of this region, the strength improvement was small though not insignificant. If surface area alone were the determining factor, the strength should have increased linearly with surface area throughout the region investigated. These results, however, applied only to surkhi composed of particles of more or less uniform size. When surkhi of particles of mixed sizes was used, strength tended to decrease with increased surface area. These results could only be explained on the basis that it was not only the strength of the bond at the interface that was important in determining the final strength of the aggregate, but also the intrinsic strength of the particles themselves, which means both particle size and surface area must simultaneously be considered for best results.

A further complication must be considered at this stage. In considering the strength of interfacial bond, it must be remembered that the strength of the bond has been observed to vary with the thickness of the cementing layer². It is perhaps not generally realized that the thinner the cementing layer, the greater its strength. In fact, the strength of an extremely thin bonding layer may be several times that of the mass strength of the cementing material. It is evident that the thickness of the cementing layer will be a minimum in the neighbourhood of the points of contact between the solid particles and it is at these points that the bond will be strongest. Thus, the importance of the number of contact points and size and shape of the inter-particle spaces becomes apparent. In powder metallurgy practice, cases occur of compacts in which cementing action is produced by sintering together particles of identical composition. In such cases the number and area of contact points are of chief interest.

From these observations and from a number of others in several fields of industry, for example, carbon electrodes, rubber mixes, plastic-filler compositions, paints, etc., it is forcefully brought home that a detailed mathematical study of fundamental character is long overdue. This will not only enable the enormous amount of experimental data now available to be rationally interpreted, but also assist in guiding future work along more profitable lines. Some theoretical work in packing problems of simple shaped particles and porosity calculations has in fact been published³, but a great deal remains to be done in the case of practical problems of a generalized character. The whole field may be divided into two sets of problems—geometrical and physical.

Geometrical problems will involve the investigation of the relationships between particle size distribution of a set of particles of a given shape on the one hand and packing density of powders, the number and nature of contact points and the shape and size of interstices on the other, such as, for example:

- (a) Given a particle size distribution of particles of a given uniform shape, what would be the expected range of variation of (i) packing densities, (ii) the number of contact points, and (iii) the size and shape of interstices?
- (b) Given the shape of particles, what would be the optimum size distribution within a given range of sizes, which will lead to (i) maximum packing density, (ii) maximum number of points of contact, (iii) minimum size of interstices?

Physical problems will involve the investigation of the relationship between the properties of the two component phases and those of the bond at the interface on the one hand and the properties of the aggregate mass on the other. The most important property for general application to a large number of industries is the mechanical strength, while other properties will also have to be considered such as, for example, extensibility in rubber mixes, softening properties or plasticity of plastic compositions, refractoriness in refractories, porosity in concretes and plasters, hardness in pencils, friction coefficient in carbon brushes, chemical reactivity particularly to atmospheric influences and other reagents to which a product may be exposed in practice, etc.

Among physical problems two classes of problems may be visualized. In one set, let us say, physical properties of a powder and cementing material are known and also its geometrical characteristics, such as shape and size distribution, it is then desired to calculate the physical properties of the aggregate mass. In the second set converse problems will be considered, in which a particular set of physical characteristics are desired to be produced in the aggregate mass, what should then be the requirements that the component materials may have to fulfil.

Some of the extensive list of problems indicated above may appear to present great difficulties, especially in view of the fact that the shape of particles met with in practice varies considerably and in most cases does not easily lend itself to simple geometrical expression. In view of these difficulties, it may be necessary to deal with some of the problems statistically, and special statistical methods may have to be developed for the purpose. While a perfectly general treatment is awaited, some indication of the type of considerations involved and the kind of results expected may be obtained by formulating a highly simplified problem for the purpose of illustration.

Assume a material composed of two dimensional particles of circular shape and uniform size packed in the most dense formation in one plane and bonded together by a cementing material in the interstitial spaces. It is required to calculate the tensile strength of the aggregate mass in terms of known strengths of the components.

Let the radius of particles be r and its mass strength S_p , mass strength of the cementing material be S_c and that of the bond S_b . For the sake of further simplicity let differences in elasticity be neglected.

The hexagonal mode of densest packing is shown in Fig. 1 with the axes of reference passing through the centre of one of the particles.

Now it is obvious that the strength S of the aggregate mass in the y direction will vary continuously from $y=0$ to $y=y_1$, where there will be a point of discontinuity. Between $y=y_1$, and y_3 , S will again vary

continuously, but half-way between y_1 , and y_3 , i.e., at y_2 , S will go through a maximum or a minimum point. Furthermore, S beyond y_2 , up to y_4 will be a mirror image of S below y_2 . The cyclic variations will be then repeated beyond y_4 . Thus, all that is necessary for the purpose of analysis is to consider the region $0 < y < y_2$.

Let us further simplify the problem and consider two special cases as follows:—

Case I. Assume $S_b \gg S_p$ and S_c , and let $S_c = nS_p$.

Then the strength of the aggregate mass S becomes

$$S = S_p \left(n + \frac{1-n}{r} \sqrt{r^2 - y^2} \right), \text{ for } 0 < y < (\sqrt{3}-1)r \dots \dots \dots (1)$$

$$S = S_p \left[n + \frac{1-n}{r} \left(\sqrt{r^2 - y^2} + \sqrt{2(1-\frac{1}{3}n - 2r^2 - y^2)} \right) \right], \text{ for } (\sqrt{3}-1)r < y < \frac{\sqrt{3}}{2}r \dots \dots \dots (2)$$

This gives a plot as shown in Fig. 2. It is obvious that for $n \gg 1$, the particle strength S_p alone is the determining factor; but for $n < 1$, both S_p and S_c determine the strength of the aggregate mass.

Minimum value of S in this case occurs at

$$y = (\sqrt{3}-1)r$$

and the strength of the aggregate may be expressed as

$$S = S_p \left[n + (1-n) \sqrt{2\sqrt{3}-3} \right] = S_p (0.682 + 0.318n) \dots \dots \dots (3)$$

In particular, when $n=0$, i.e., when mass strength of cement is negligible,

$$S_{\min} = 0.682 S_p \dots \dots \dots (4)$$

The practical significance of these deductions becomes at once apparent when one considers that S_b , in practice, is usually much larger than S_c and sometimes even larger than S_p . Thus it may be said that given a cementing material, the mass strength of an aggregate can be increased considerably by proper choice of the particle material. The reverse, however, is not true, that is, given a powder mass to be bonded, the maximum strength is limited to the particle strength itself, no matter how strong the cementing material. It may be pointed out that though these conclusions will qualitatively hold in a three-dimensional problem, quantitative results have still to be worked out.

Case II.—Now let us look at the structure in which S_p and S_c are both large compared to S_b .

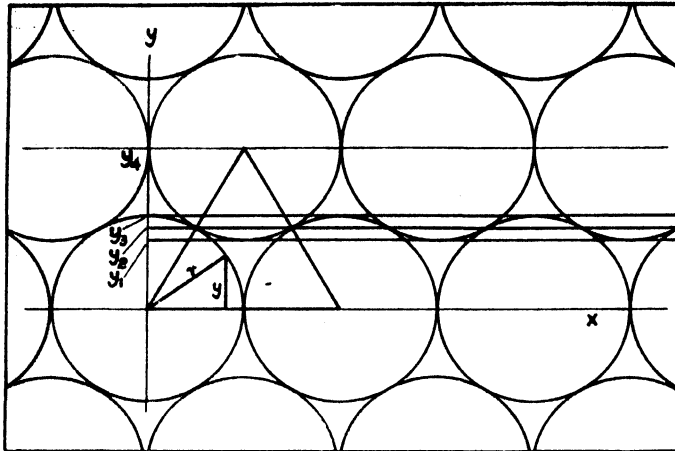


Fig. 1.

S_b cannot, in general, be taken to be independent of the angle between the bonding surface and the direction in which stress is applied. In fact, variation in normal tensile strength of bonding materials in a bond and its shear strength have formed the subject matter of some experimental investigations⁴ but it is not known whether the variation of bonding strength as a continuous function of the angle of stress has been studied. On the other hand, it has been noted tensile and shear strengths of a bond do not vary systematically, either for a given bonding material or for a given set of bonded surfaces.

In general we may define

$$S_b = S_o f(\theta) \dots \dots \dots (5)$$

Fig. 2.

where θ is the angle between the surface and the stress direction and S_o is the shear strength. It is not possible to postulate the form of $f(\theta)$ based on available experimental data, but reasonable forms for $f(\theta)$ may be assumed to be

$$f(\theta) = \cos \theta + (1+m) \sin \theta \dots (6)$$

$$\text{or } f(\theta) = 1 + m \sin \theta, \dots \dots (7)$$

where m is such that the tensile strength $S_t = (1+m) S_o$, m may be zero, positive or negative, and θ limited to $0 < \theta < \frac{\pi}{2}$. In equation

(6), it is assumed that the strength of the bond in any direction θ is the sum of the components of tensile and shear strengths in that direction. This leads to a strength maximum between

$\theta = 0$ and $\theta = \frac{\pi}{2}$, much higher than the shear or tensile strengths. Equation (7), however, gives a more plausible distribution and

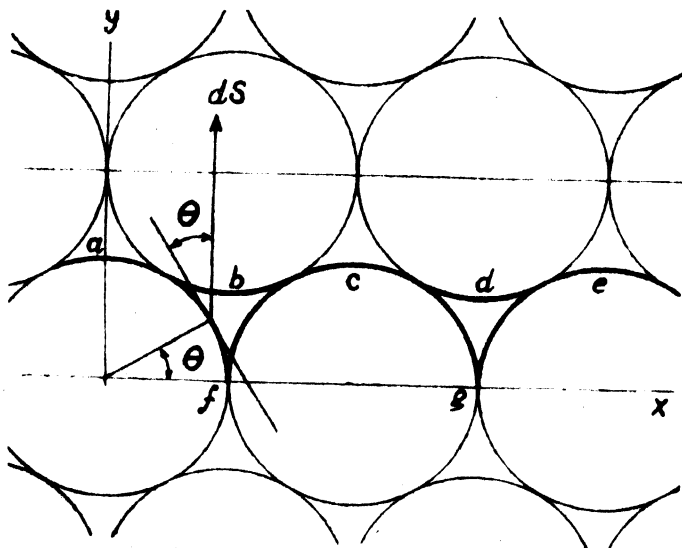
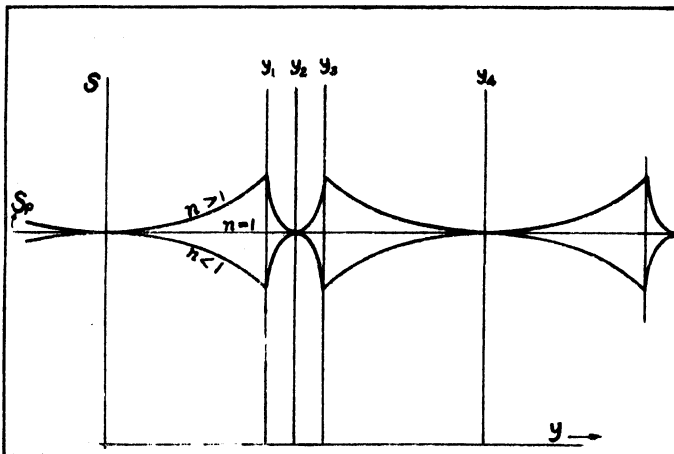


Fig. 3.

hence it has been used in the following discussion.

Rupture in this case may take place along line *abcde* (case IIA) or along line *afcge* (case IIB), as shown in Fig. 3.

In case IIA,

the rupture strength S becomes

$$S = 2S_o \int_{\frac{\pi}{3}}^{\frac{\pi}{2}} (1 + m \sin \theta) d\theta$$

$$= S_o \left(\frac{\pi}{3} + m \right) \dots \dots \dots (8)$$

and, in case IIB,

$$S = S_o \int_0^{\frac{\pi}{2}} (1 + m \sin \theta) d\theta$$

$$= S_o \left(\frac{\pi}{2} + m \right) \dots \dots \dots (9)$$

It is clear, therefore, that rupture will be as in case IIA along *a b c d e* and the strength will be slightly more than the tensile strength S_T of plane bonded surfaces. In particular

for $m = -0.5$, $S = 0.55 S_o$, while $S_T = 0.50 S_o$,
for $m = 0$, $S = 1.05 S_o$, while $S_T = 1.00 S_o$,
and
for $m = 0.5$, $S = 1.55 S_o$, while $S_T = 1.50 S_o$.

It is obvious that the increment arises due to curvature of the bonded surfaces, which, in case of three dimensional problems involving different sizes of particles, instead of one uniform size, will be even more pronounced. Furthermore, if the variation of S_b with film thickness was also taken into account, further improvement will result in strength, because there exist two points of contact per particle (in case IIA). In three-dimensional problems of mixed particle size, the number of these points of contact will also increase and the film thickness decrease, which will further add to the strength of the aggregate mass.

In other words, in a practical case, in which bonding strength plays a predominant

part, the strength of the aggregate mass may be expected to be several times that of the plane bonded surfaces, merely by virtue of the geometry of the aggregate mass. It may, however, be pointed out that in a practical case of this nature, S_c need not be appreciable, for the interstices between the particles of mixed sizes would be of a sufficiently fine size, where only the bonding strength variation with film thickness would be the determining factor.

Without discussing in detail the general case in which S_p , S_c and S_b are all of comparable magnitudes, it may be visualized that several special cases will arise and that a number of modes of rupture will have to be investigated. Since the purpose of this note is merely to bring out the nature of the problems involved, which may ultimately have to be solved by specially designed statistical methods, it is not considered necessary to pursue the above problem any further. Suffice it to hope that some interest will be aroused in this subject, which requires the serious attention of the mathematician and the mathematical physicist. Extensive experimental work of a fundamental character is also indicated, such as, for example, (i) the determination of the various forms of $f(\theta)$ in equation (5) for various materials of interest to industry, (ii) the elucidation of the relationship between bonding strength and film thickness of the cementing materials of interest, and (iii) experimental confirmation of any theoretical results that may be obtained.

References

- 1 Ch. A. R. Khan and L. C. Verman, *Bull. Indian Ind. Res.*, 1941, No. 24.
- 2 Cf. L. C. Verman, *Lond. Shellac Res. Bur., Tech. Paper*, No. 3, 1935.
- 3 R. Meldau and E. Stach, *J. Inst. Fuel*, 1934, 7, 336; L. C. Graton and H. J. Fraser, *J. Geol. (Chicago)*, 1935, 43, 785; H. J. Fraser, *J. Geol. (Chicago)*, 1935, 43, 910; C. G. Furnas, *Ind. Eng. Chem.*, 1931, 23, 1052; F. O. Anderegg, *Ind. Eng. Chem.*, 1931, 23, 1058; etc.
- 4 L. C. Verman, *loc. cit.*

CINNAMON-LEAF OIL

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EUGENOL is an important aromatic extensively used in perfumery and pharmacy. Though a constituent of many essential oils, the commercial supplies are mainly derived from clove oil, which contains 78 to 98 per cent. Cloves are, however, cultivated in India only to a limited extent, and, consequently, an alternative source of eugenol has to be looked for. This is fortunately available in cinnamon (*Cinnamomum zeylanicum* Breyn.) leaf oil in which it is present to the extent of 70 to 90 per cent.

C. zeylanicum is a medium-sized or large tree which grows in many tropical countries such as India, Mauritius, Seychelles, Jamaica and Ceylon. Although one of the earliest known spices, its systematic cultivation does not appear to have been undertaken till 1770; previous to this, the spice was derived from wild or uncultivated trees. It was till recently one of the popular spices but its use has greatly declined. In 1919 Ceylon had 35,000 acres under cinnamon but by 1939 it had declined. Of all the countries, Ceylon has specialised in its cultivation and has consequently developed a valuable trade. She has a plantation covering 26,000 acres and annually exports 5 million pounds of cinnamon bark and 2.8 million ounces of bark and leaf oils¹. All parts of the cinnamon tree are aromatic, but the dried inner bark of the shoots from coppiced trees and the leaves are the only parts which are commercially exploited. Cinnamon bark is used as a spice and for the extraction of an oil, the major constituent of which is cinnamic aldehyde, being present to the extent of 38 to 76 per cent. The leaf oil is altogether different from this, and contains a high proportion (70 to 90 per cent.) of eugenol.

Cinnamon tree has been primarily prized for its bark. The best quality is grown in an alluvial sandy soil with good rich subsoil, from the sea coast up to an altitude of about 2,000', with an average temperature of about 85° F. and an annual rainfall of 85" to 100", not intermitted with long spells of dry

weather. When grown on laterite gravel the growth is quicker but the bark produced is coarser. Free exposure to sun produces better quality tree than when grown in shade. Experience in Mysore suggests that both growth and quality are much influenced by soil.

The tree flowers more or less throughout the year but most abundantly in January and February, and the fruit ripens from June to August. The seeds which are oily do not long retain their viability; they are sown soon after ripening either in a nursery to be transplanted in October and November or on the spot in plots 1 foot square and 6' to 7' apart. If sown in nursery they are put 9" apart, watered and slightly shaded until the seedlings are 6" to 8" high. These are transplanted when 3, 4 or 12 months old in holes 6' to 12' apart. The seeds take about three months to germinate. Cowdung or leaf-mould manure is recommended. In cultivation the tree is grown as a bush. Trees grown in low-lying areas require six or more years before becoming peelable, as compared to those grown on sandy soils; the latter are ready for peeling in four to five years. Those grown in low-lying areas produce bark of low oil content.

The plants attain 7' to 8' in six to seven years, and those which are then fit to be peeled are cut. The shoots which spring up are thinned out when they are 2, 3 or 4 years old, or even at an earlier age. They are not cut when less than $\frac{1}{2}$ " or more than $2\frac{1}{2}$ " in diameter. The whole crop in one plot is never cut over all at once, but those shoots only are selected which appear fit to be peeled. The main point attended to seems to be to cut the shoots when quite young and tender; it is said that the bark of the older shoots yields inferior cinnamon.

The flush or growth of young red leaves follows the first rains and, as the leaves turn dark green, the shoots are cut for peeling. The cutting is done between May and October. The bark is then peeled off from each shoot

in three or four long narrow strips, tied in bundles and left for 24 hours. After this the inner bark, which is aromatic, is removed and prepared for the market. In three to four years after planting, about 50 to 60 lbs. of bark (quills) per acre may be expected from the first crop, the yield increasing until the tenth year when the maximum crop of 100 to 150 lbs. may be obtained. The best Ceylon estates produce about 100 lbs. of quills per acre. The yield of the oil from bark is usually 0.5 to 1 per cent., but varies as does also its quality, according to the method of distillation.

When grown primarily for leaves, the tree is pruned heavily to encourage large increase of shoots. In Seychelles it has been found that:—

- “(1) The maturity of cinnamon leaves is not attained in 12 months' growth and the necessary time appears to be between 18 months and two years with trees growing under good conditions.
- (2) Seasonal variation of the oil content in the leaves does not appear to occur during the first year's growth, but during the second year's growth a maximum is reached in the two months prior to the “repoussé” or growth which takes place in May and September.”

Exact figures are not available but it is stated that 60 to 100 lbs. of air-dried leaves per acre can be obtained.

In India, cinnamon tree grows in evergreen forests of Western Ghats from Konkan southwards to Tinnevely at low levels. It is also cultivated in Malabar, Tinnevely and Tellicherry, though not on any large scale. The high quality of Ceylon cinnamon bark or leaf has been developed through careful cultivation and proper harvesting, and, even though the bark from Tellicherry is said to be equal to the bark from Ceylon, very little trade has developed either in the bark, bark oil or leaf oil. Apart from Tellicherry, the bark produced elsewhere in India is coarse and inferior to Ceylon bark. This is not surprising. Even in Ceylon, where the finest quality of cinnamon is produced, it is recognized that *C. zeylanicum* is an extremely variable tree and yields different qualities of bark in different localities. Whether these differences are due to the climatic and edaphic conditions, or to the differences in varieties and forms, has not yet been elucidated. The same doubts also hold good in the case of Indian cinnamon. Some of the confusion is also perhaps due to the fact that forms probably belonging to *C. iners* Reinw., *C. wightii* Meissn. and *C. macrocarpum* Hook. f. have been described under *C. zeylanicum*. According to Beddome (*Flora Sylvatica for Southern India*, 1872, p. 202), the moist forests of south-west from sea level up to the highest elevation have seven or eight well-marked varieties so connected *inter se* by intermediate forms that it is not possible to find constant characters

TABLE I

	Oil from Cardol Corporation, Mangalore					From North Malabar. The oil was dark brown in colour and cloudy in appearance.
	Yellow brown in colour, clear and limpid		Oil No. II re-distilled with steam (82.6% of the original oil). Almost colourless, clear and sparkling	Dark brown in colour		
	I	II	III	IV	V	
Density at 30° C.	1.0443	1.0615	1.0680	1.0620	1.0540	
Refractive index at 30° C.	1.5223	1.5235	1.5285	1.5305	1.5275	
Solubility in 70 per cent. alcohol	1.5	1.5	—	1.5	1.5	
Eugenol content per cent. (absorption method by weight)	70.0	71.3	73.3	87.2	81.2	
Acid value	—	—	—	15.7	14.0	
Saponification value	—	—	—	20.4	30.8	
Ester value	—	—	—	4.7	16.7	
<i>Fractions</i>						
(1) Up to 240° C.	—	17.2%	—	6.2%	19.6%	
Density at 30° C.	—	1.0380	—	—	1.0087	
Refractive index	—	1.5230	—	1.5192	1.5115	
Eugenol content per cent.	—	68.0	—	—	74.6	
(2) Between 240° to 248° C.	—	66.1%	—	75.9%	58.3%	
Density at 30° C.	—	1.0320	—	1.0580	1.0546	
Refractive index at 30° C.	—	1.5250	—	1.5310	1.5298	
Eugenol content per cent.	—	70.0	—	88.7	90.3	
(3) Between 248° to 255° C.	—	—	—	—	11.8%	
Density at 30° C.	—	—	—	—	1.0617	
Refractive index at 30° C.	—	—	—	—	1.5298	
Eugenol content per cent.	—	—	—	—	81.7	
(4) Residue above 255° C.	—	16.7%	—	17.9%	10.3%	

worthy of specific distinction. According to Menon², what is known as *C. zeylanicum* in S. Kanara, especially in N. Mangalore, is perhaps, in part at least, *C. macrocarpum*. Local people of S. Kanara, however, recognize four different types according to the taste of the leaves. These are (1) the *tej*, pungent, (2) the *kadwa*, bitter, (3) the *mitha* or sweet and (4) the *phika* or insipid variety. Of these, only the leaves of the *tej* and the *kadwa* varieties are distilled because of the richness of the oil in eugenol. Table I describes the oils distilled by Cardol Corporation, Mangalore, from leaves grown in Coondapur, Karkala and Puttur taluks (South Kanara).

It will be seen that the cinnamon-leaf oil produced in South Kanara is of high quality, equivalent to clove oil in eugenol content. But only a limited quantity of this oil is produced in that area, although the industry is said to be a hundred years old.

The Forest Department auctions areas of about 100 square miles each (called circles) for distilling cinnamon-leaf oil. In each circle, the successful bidder selects a centrally situated site with plentiful supply of water and fuel, and erects five small, crude, direct-fire stills. He is not permitted to erect more than five stills in any one circle. The still consists of a wide-mouthed copper vessel of about 3' in diameter. The mouth of the still is covered with an inverted earthen pot, the juxtaposed mouths of the two vessels being plastered with earth to prevent leakage. The inverted earthen pot has a suitable hole punctured on its side to accommodate the long hollow bamboo pipe, which serves as an air condenser. Twenty-five pounds of leaves are put and water added to fill one-third of the still, which is then heated with direct fire and the oil distilled. The condensing system is very imperfect and almost half of the oil escapes uncondensed.

Since the oil-yielding varieties of cinnamon occur scattered in the forest and collection of leaves is difficult, time and labour consuming, the method of distillation is wasteful. Even so the distillers produced the oil in 1942-43 at about Rs. 5 per lb. It will be observed that the industry is still in the hands of ignorant distillers who produce the oil in direct-fire stills. It is, therefore, time that efforts be made to develop it on an organized basis and to introduce steam-distillation so as to assure full recovery of the oil from the leaves and to produce a superior oil of uniform quality. The leaf oil has a fairly large

local as well as outside demand, provided it could be produced as cheaply as clove oil. It may be stated that the yield of oil from cloves is 14 to 21 per cent. as against 2 per cent. in dried cinnamon leaves; but plentiful availability of leaves at low cost should make up for the poor yield. It has been estimated³ that nearly 100,000 lbs. of leaves yielding 2 per cent. of the oil, on dry basis, could be collected from North Kanara alone. In fact Seychelles is concentrating on leaf oil and has developed a valuable trade. The primary need of the industry in India is, therefore, the investigation and isolation of proper varieties, forms or strains of the cinnamon tree which would yield the finest quality of the bark and leaves, and also their reaction to climatic and edaphic conditions together with the finding of optimum conditions for harvesting and preparation of the bark for the market.

While attention is paid to improvements in production of the leaf oil the bark should not be neglected, since the sale of good-quality bark and the bark oil from low-quality bark should both be able to yield additional income to the distillers of leaf oil and to the forests, and should thus act as an incentive to larger production. As has been remarked above, Tellicherry bark is of as high a quality as Ceylon cinnamon bark. It may not be possible for Tellicherry bark to capture any considerable proportion of the trade in Ceylon bark, but it should be able to find local markets considering that India imports from Ceylon annually Rs. 8 lakhs worth of cinnamon (including the bark from China which is derived from another species, *C. cassia* Blume). The quantity of bark available from Tellicherry may not be large (no figures are available) but together with the coarse bark produced in neighbouring areas, Malabar and elsewhere, it may be considerable. The coarse bark may not sell as spice but there is no reason why it should be unsaleable, if it were to be distilled for its oil and the oil properly rectified to increase the proportion of cinnamic aldehyde, the important constituent of cinnamon bark. The bark could be distilled when the season for the distillation of the leaf oil is over, thus affording longer period of employment to the local distillers.

References

- ¹ *Perf. and Essent. Oil Rec.*, 1939, **30**, 375.
- ² *Ind. Forester*, 1921, **47**, 77.
- ³ Karamchandani, *Ann. Rpt. on Forest Utilization, Bombay*, 1940-41, p. 15-16.

COAL TAR AND ITS DERIVATIVES*

PART I—COAL TAR PRODUCTION AND REFINING IN INDIA

By C. J. FIELDER

Definition and Origin

THE official definition of tar, adopted by the *British Standards Institution* and by the *Permanent International Association of Road Congresses*, is as follows :—

Tar.—A bituminous product, viscous or liquid, resulting from the destructive distillation of organic materials.

The word "tar" must always be preceded by the name of the matter from which it is produced : coal, shale, peat, vegetable matter, etc. Its mode of production should also be indicated.

From the above definition it follows that tar is a bituminous material, i.e., a substance characterized by the presence of bitumen. The official definition of "Bitumen" accepted by the *British Standards Institution* and the *Permanent International Association of Roads Congresses* is as follows :—

"Mixtures of hydrocarbons of natural or pyrogenous origin or combinations of both (frequently accompanied by their non-metallic derivatives) which can be gaseous, liquid, semi-solid or solid, and which are completely soluble in carbon bisulphide."

According to the definitions quoted above, a tar, must therefore contain substances which are predominantly soluble in carbon bisulphide.

Coal tar is a by-product of the coking of coal. In the process of coking or carbonizing, coal is subjected to destructive distillation in suitably designed retorts or ovens and the volatile products pass over into collecting mains, coolers and various types of detarrers designed to separate the liquid and solid from the gaseous products of carbonization. Coal tar, thus formed, is a heavy black viscous liquid associated with a certain amount of ammoniacal liquor which may be partially separated by settlement in open tanks.

The viscosity, specific gravity and chemical composition of coal tars vary appreciably with the conditions under which the coking or carbonization process is carried out.

The main factors controlling both the yield and composition of the tar produced are : (a) nature of coal processed, (b) design of coke oven or retort, (c) temperature of coking, and (d) rate of coking. The coal tars obtained in modern industrial processes conform to the following main types :—

1. High temperature coal tar (coke oven)
2. High temperature coal tar (Horizontal Retort.)
3. High temperature coal tar (Vertical Retort, continuous or intermittent)
4. Low temperature coal tar.
5. (a) Producer gas coal tar.
(b) Blast furnace coal tar.

In India only two of the above types of coal tar are produced in quantity, viz.— (1) High temperature coal tar from coke ovens, and (2) High temperature coal tar from horizontal gas works retorts.

It must be appreciated that coal tar is strictly a by-product of coking and that either coke or coal gas is the main product. In consequence, the coking process is so designed to give the maximum yield of either metallurgical coke or coal gas to the desired specification and the resulting production of coal tar is, in either case, quite incidental. The more scientific and efficient utilization of coal is a subject which will demand the increasing attention of world-wide research, and it is possible that coal tar will come to be regarded in the future as more of a primary product than it is at present. The industrial treatment of coal may then be designed in such a way as to produce higher yields of the better grades of coal tar, in view of its very great importance to the chemical industry as a raw material for the manufacture of a wide range of essential organic chemical substances.

Chemical Nature

Coal tar is an organic liquid of exceedingly complex chemical composition and upwards of 200 different chemical compounds have been extracted from it and identified. The

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temperature at which carbonization takes place has a predominating influence on the type of coal tar produced.

Low temperature carbonization, at a temperature range of 450-700° C., produces a soft semi coke and a comparatively high yield (8-13 per cent. by weight) of a thin coal tar in which paraffinic compounds are present to an appreciable extent.

High temperature carbonization, at a temperature of 900-1200° C. produces a hard metallurgical coke and a comparatively lower yield (4-6 per cent. by weight) of a thick coal tar which is predominantly aromatic in character. As the temperature of carbonization is raised, the primary paraffinic hydrocarbons are cracked to an increasing extent into aromatic hydrocarbons.

This contrast in the chemical nature of low and high temperature coal tars is illustrated in the following figures quoted by C. M. Fisher¹ which are based on average results from 15 representative American coals :—

	Low temperature coal tars (600° C.)	High temperature coal tars (1,000° C.)
Yield of tar	8.56% by weight of coal	5.66% by weight of coal.
Specific gravity	1.059	1.18
Tar acids	18.4% by volume	4.6% by volume
„ bases	1.1% „ „	1.3% „ „
Neutral oils	40.0% „ „	26.0% „ „

The composition of the neutral oils is as follows :—

	By volume	By volume
Olefines	12.9%	13.3%
Aromatics	61.3%	83.3%
Paraffins	25.8%	3.3%

Weiss and Downs, by analysis of four representative high temperature coke oven tars in the U.S.A. record the following average composition :—

	% by weight of dry tar
<i>Light Oil</i>	
Crude benzene and toluene	0.3
Xylene, cumenes, etc.	1.1
Coumarone, indene	0.6
<i>Middle and Heavy Oils</i>	
Naphthalene	10.9
Methyl naphthalenes	4.2
Di-methyl „	3.4
Acenaphthene	1.4
„ range unidentified	1.0
Fluorene	1.6
„ range unidentified	1.2

	% by weight of dry tar
<i>Anthracene Oil</i>	
Phenanthrene	4.0
Anthracene	1.1
Carbazole, etc.	2.3
Anthracene, range unidentified	5.4
Phenol	0.7
Cresols, xylenols	1.5
Tar Bases	2.3
Yellow solids of pitch oils	0.6
Pitch greases	6.4
Resinous bodies	5.3
Pitch (m.p. 235° C.)	44.7
	100%
“ Free ” carbon	10.6%
Sp. gr. at 15.5° C.	1.186

The above composition cannot be regarded as typical of Indian coal tars in as much as the percentages of naphthalene, anthracene, phenol, cresols, etc., therein are found to be appreciably lower than those reported above.

In India no low temperature carbonization is at present carried out, although experimental trials have been initiated, and all coal tar is of the high temperature carbonization type.

High temperature coke ovens originated in India in 1909 with E. I. Rly. installation at Giridih and this was followed by a number of other units in the Jharia Coal Fields.

Physical Nature

Coal tar is a colloidal suspension of carbonaceous particles or micelles in an oily medium or continuous phase. The micelles constituting the disperse phase vary considerably in size from macrons to microns down to ultra microns. Each micelle is believed to consist of an inner core of the less fusible resins of high carbon/hydrogen ratio, surrounded by protective layers of the more fusible resins.

The addition of certain organic solvents to coal tar results in a breaking down of the protective layers by solvent action and flocculation of the insoluble core of the micelles. The degree of flocculation resulting is dependent on the surface tension of the particular solvent employed which thereby affords a means of investigating the composition of coal tars by solvent extraction methods as developed at the *Department of Scientific and Industrial Research*² in the United Kingdom.

By such methods coal tars can be resolved into four groups :—Oils (A), resins (B), "free carbon", non-resinous (C_1) and resinous (C_2). The technique usually employed is first to remove as much of the oils as possible by vacuum distillation to form a pitch residue.

The latter is then extracted by benzene which dissolves the oil and resin groups and flocculates the "free carbon" groups. On pouring the benzene extract into light petroleum naphtha (B.P. 40° - 60° C.) the resins (B) are precipitated and the oils (A) can be recovered by distilling off the benzene.

The "free carbon" group, on extraction with pyridine, is resolved into the soluble resinous type, C_2 and the insoluble type C_1 . Examination of these four groups shows that considerable differences exist as regards their chemical nature and physical properties and in the relative proportions in which the groups are present in coal tars of various origins.

A typical composition of a soft pitch derived from a high temperature coke oven Indian coal tar is—

	% by weight
Non-resinous oils, A	61
Resins, B	15
"Free carbon" non resinous C_1	11
"Free carbon" resinous C_2	13

The non-resinous fraction (A) is a yellowish-red, semi-solid or viscous liquid containing some crystalline matter. The resins (B), are light to reddish-brown in colour and on heating become soft and plastic at about 150° C. When dissolved in tar oils they yield viscous adhesive solutions.

"Free carbon", non-resinous (C_1) is an infusible black amorphous powder while "free carbon" resinous (C_2) is brownish black and exhibits very adhesive properties when dissolved in tar oils.

Approximate molecular weights and carbon/hydrogen ratios of the various groups are as follows :—

	Mol. wt.	C/H Ratio
Non-resinous oils "A"	225	1.3 : 1
Resins "B"	380	1.5 : 1
"Free carbon," resinous C_2	450	1.75 : 1
"Free carbon," non-resinous C_1	Very high	2.5 : 1

It seems possible that more extensive investigations into the constitution of coal tars by methods of solvent extraction may influence future refining methods for the production of road tars and tar paints and render possible a closer control on the

properties and performance of such refined products.

Production in India

The Indian coking industry has gradually developed in step with the indigenous iron and steel industry which is the main consumer of metallurgical coke. At the present time (1944) the total coking capacity of high temperature coke ovens in India is approximately 3.5 million tons of coal per annum, and the corresponding output of coal tar is 88,000 tons per annum. It will be seen from these figures that the yield of coal tar from coal is 2.5 per cent. by weight or 4-5 gallons of coal tar per ton of coal coked, i.e., approximately one half only of that obtained in Europe and America.

This low yield of coal tar, which has not been taken into account in some recent technical reports dealing with the potential resources of chemicals obtainable from coal tars produced in India, is a significant fact and is attributable to the comparatively low quality of Indian coals and their high ash content.

Of the above maximum production capacity of 88,000 tons of coal tar per annum, 84 per cent. or 73,800 tons, is located with the two large iron and steel producing companies, viz. *Tata Iron and Steel Co.* at Jamshedpur and *Indian Iron and Steel Co.* at Hirapur and Kulti near Asansol in the Raniganj Coal Field.

The following table shows the gross and net annual productions of coke oven coal tar in India since 1935 together with the average price realized by the producers on sales to market and general purchasers, other than distillers.

	Net production	Gross production	Average price of crude tar, ex suppliers' works Rupees per ton
	Tons	Tons	
1935—36	57,500	59,000	43
1936—37	61,500	64,000	43
1937—38	58,000	64,500	50
1938—39	52,000	62,500	50
1939—40	62,500	70,500	55
1940—41	72,500	82,000	55
1941—42	74,250	80,750	65
1942—43	51,500	72,500	65
1943—44	38,500	64,500	65

The net production of coke oven coal tar available for disposal is normally 90-95 per cent. of the gross production, the balance being retained at producers' works for internal use. Production of coke oven

coal tar reached a peak in 1941 but has since fallen away seriously due to shortage of coal. The *net* production of coal tar has been even more drastically reduced than the gross production (given above) in consequence of war-time conditions and the necessity of using considerable quantities of coal tar as a fuel in steel furnaces.

In addition to coke oven tar, there is a small production of gas works coal tar (Horizontal Retort type) manufactured by the *Oriental Gas Co., Ltd.*, in Calcutta and *The Bombay Gas Co., Ltd.*, in Bombay. Their joint production of coal tar amounts to 6,500 tons per annum, bringing the total production capacity of coal tar in India to 94,500 tons. The yield of gas works coal tar is 10 gallons, or 5 per cent. by weight approximately, per ton of coal carbonized.

The high temperature coke oven coal tars produced in India vary somewhat in composition, and the following analysis illustrates the nature of the three main types of Indian coal tars :

	A	B	C
Viscosity by modified (B.R.T.A.) Redwood Viscometer at 30°C.	5"-15"	1"-5"	<1"
Sp. gravity at 15° C.	1.18-1.22	1.10-1.16	1.195
Ammoniacal liquor	1-3%	2-5%	2-5%
Oils distilling up to 200° C.	1.5%	4%	8% by wt.
From 200-270° C.	10-15%	15-20%	18% "
" 270-300° C.	5-7%	6-8%	5% "
Crude tar acids	0.8-2.0%	2.5-4.5%	3.5% by vol.
Crude naphthalene	2.0-8.0%	1.0-2.0%	2.5% by wt.
Medium pitch (Softening Pt. 70° C.) content	60-65%	50-60%	65% by wt.
"Free Carbon" insoluble in toluole	6-10%	2-4%	17% by wt.

Type A is representative of the coal tar produced in the latest design rapid-coking ovens operating at 1,200° C. Coal tars of this type constitute 85 per cent. of the total coal tar production and are characterized by comparatively low oil and tar acid contents and high naphthalene content.

Type B is representative of coal tars produced in slower coking ovens operating at 900° C. Coal tars of this type constitute only 8 per cent. of the total coal tar production and are characterized by higher oil and tar acid content and low naphthalene and "free carbon" contents.

Type C is representative of gas works coal tar production which comprises 7 per cent. only of the total. It is characterized by higher oil and tar acid content and high "free carbon" content.

Crude coal tar is sold by the producers to the coal tar distillers for refining and to bazaar dealers who dispose of it chiefly for painting of country boats and treatment of fishing nets. A certain amount is also utilized by railways and other consumers for painting and dipping iron and steel work. Prior to 1939, approximately 10,000 tons per annum, representing 20 per cent. of the total coal tar production, were disposed of to dealers, railways, etc. Exports of coal tar from India amounted to approximately 2,500 tons per annum or 5 per cent. of production.

A considerable glut of coal tar was experienced in India from 1934 to 1938 and the chief producers of coke oven coal tar formed a selling association whereby arrangements could be made for disposing of the surplus coal tar as a fuel in the steel works after satisfying the demands of the distillers and bazaar markets. Some 15,000 tons per annum were disposed of in this manner until 1938 when the demand for coal tar

for refining considerably increased and burning was discontinued. Recourse to burning coal tar as a fuel was again necessitated in 1942 owing to shortage of coal at the steel works.

Coal Tar Distillation

The quantity of coal tar distilled and refined in India has steadily increased from 1930, when it is estimated

to have been 15,000 tons per annum only, to 1942 when it exceeded 60,000 tons.

Year	Crude tar refined Tons
1933-34	26,500
1935-36	30,000
1937-38	44,700
1939-40	46,200
1941-42	61,700
1943-44	33,700

Coke oven tars are refined in India by the following distillers:—

<i>Bararee Coke Co., Ltd.</i> , Kusunda	} Jharria Coal Fields,
<i>Shalimar Tar Products</i> (1935) Ltd., Lodna.	
<i>Bengal Chemical and Pharmaceutical Works, Ltd.</i>	} Panihati near Calcutta.

Prior to 1939, distillers mainly confined their efforts to the production of road tars, creosotes, disinfectants and pitch. Since the

war, however, it has proved possible for them to extract and dispose of refined naphthalene, phenol and cresylic acids, in addition to the aforementioned products.

Generally speaking, however, Indian coal tars are comparatively poor in the more important by-products, particularly the tar acids (phenol and cresols), and their potential indigenous production is likely to fall considerably short of the country's post-war requirements.

The combined distillation and refining capacity of the above distillers is more than sufficient to deal with the maximum production of crude coal tar from all coke oven installations now existing in the country.

Comparatively small quantities of gas works coal tars are also distilled in a number of plants existing in Calcutta and Bombay.

The refining of coal tar consists essentially of distillation, the distillates being fractionated to yield products of the desired boiling point range.

The residual products from distillation comprise road tars of various specified viscosities and coal tar pitch, the latter being usually graded as soft, medium or hard, according to softening point. These residual products from coal tar distillation constitute from 60 to 85 per cent. of the raw material.

The following flow diagram illustrates the manner in which various coal tar by-products are derived:—

The main product of coal tar distillation is somewhat loosely described "Creosote Oil," a term which may be applied to any distillate of coal tar boiling above 200° C. Distillates below 170° C. are termed *Light Oil*, and those from 170°-230° C. are called *Middle or Carbolic Oil*.

Light Oil or crude naphtha as it is sometimes termed, is the lowest boiling oil fraction, obtained from crude tars. It consists essentially of the aromatic hydrocarbons, benzene, toluene, xylenes, etc., together with small quantities of tar acids (phenol, etc.), tar bases (pyridine) and resin forming compounds such as coumarone. The main products from this fraction are refined solvent naphthas.

The only coal tar produced in India which contains appreciable quantities of light oil is gas works coal tar.

The *Middle or Carbolic Oil* contains up to 25 per cent. of tar acids by volume which

may be extracted by washing with alkali. The tar acids (or phenols) comprise phenol (carbolic acid), cresols (cresylic acid), xylenols and other higher boiling phenols.

On cooling, middle oil yields a crystalline deposit consisting primarily of *naphthalene* which may be extracted therefrom and purified.

Middle oil from which the solid products have been separated, but containing enhanced percentages of tar acids (20—40 per cent. by volume), is sold as "*Cresylic Creosote*" and employed in the manufacture of coal tar disinfectants.

Coal tar creosote containing oils boiling mostly above 230° C. is marketed without further refining as a *wood preservative*.

The heavier fraction of creosote, boiling over 270° C. and having a specific gravity of 1.080 and over, is termed *Anthracene Oil*.

Heavy creosote fractions yield a solid deposit, or paste, on settlement and cooling, which consists essentially of a mixture of three solid hydrocarbons—*anthracene*, *carbazole* and *phenanthrene*, the two former compounds being of primary importance in the coal tar dye industry.

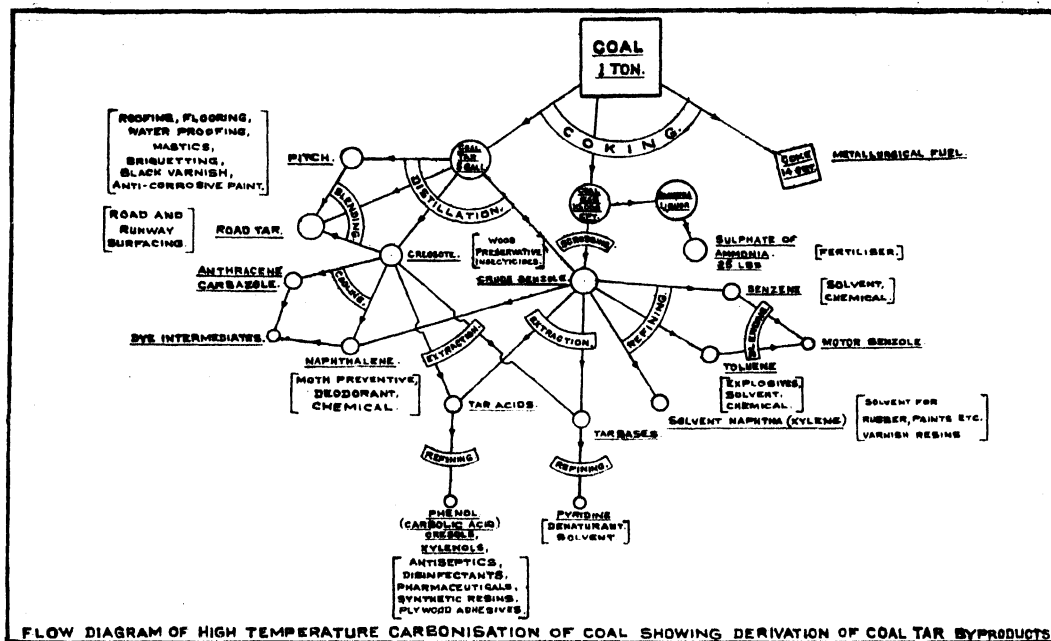
Coal Tar Distillation Plant

The coal tar is first allowed to stand in suitable tanks to permit as much ammoniacal liquor as possible to separate above the tar. The latter is then pumped via feed tanks to the stills. The distillation may be (a) *Batch* or *discontinuous type* or (b) *continuous type*.

In the case of batch distillation, "pot stills" are employed of varying capacity, usually 10—30 tons.

This type of still is fabricated with mild steel, vertically cylindrical in shape with a concave bottom and set in brickwork above a solid fuel grate in a suitable system of flues. (Fig. 1).

The still head is designed to collect the vapours and lead them to a fractionating column and thence to a water-cooled condenser. Initial heat has to be regulated with care until the water present in the tar has been expelled as frothing over is liable to occur. The distillates are collected in a series of cuts of increasing boiling point range, and it is the usual practice to assist the final stages of the distillation by means of open steam fed in through a perforated pipe.



When the required residue has been obtained after 24-28 hours' distillation, fires are drawn and the residual tar or pitch is lowered away through a drain pipe *via* a cooler to storage or, if solid, to pitch bays, where the product solidifies.

In the case of *continuous distillation*, which is to be preferred where large quantities of coal tar of more or less uniform composition are refined, units have a capacity of 20 to 40 tons of crude tar per day and plant design follows fairly closely to that originally adopted in the petroleum refining industry.

Distillation may take place in a series of three horizontal cylindrical shells through which the coal tar gravitates in a steady flow and the temperature is stepped up in successive stills from which the vapours are drawn off and condensed, producing distillates of increasing specific gravity and boiling point range.

The incoming crude first passes through a heat exchanger where it acquires heat from the outgoing residue. When distilling to a medium pitch residue, typical operating temperatures of the three stills are 230° C., 255° C. and 320° C. respectively.

The first still may incorporate a special design to facilitate the evaporation of water

present and avoid frothing, while in the subsequent stills open steam is provided from a perforated pipe to maintain agitation, assist distillation and reduce coking on the still bottom. A distillation unit of this type is illustrated in Fig. II.

Fractionation of the distillates may be provided for in overhead columns during the primary distillation or during subsequent redistillation processes. The vapours are cooled in water-cooled coil condensers and the condensates permitted to settle and cool for several days.

Distillate from the first still will conform to a Middle or Carbolic Oil, which, after straining from the solid deposit of crude naphthalene paste, can be treated for extraction of tar acids.

Distillates from the second and third stills are usually blended for sale as creosote for *wood preservation*, after separation from the solid paste.

Naphthalene paste is best separated from Middle Oil by "whizzing" in a centrifugal machine and hot pressing in a steam-heated hydraulic press to produce "Hot-Pressed" crude naphthalene.

In the case of anthracene paste, this is usually filtered through bag filters or plate filter presses.

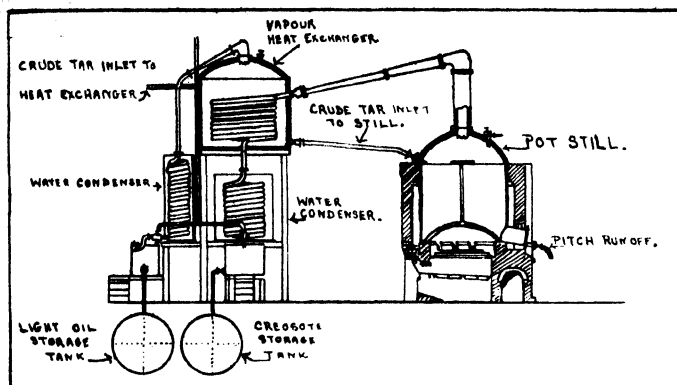


Fig. 1.—Arrangement of Tar Pot Still and Setting.

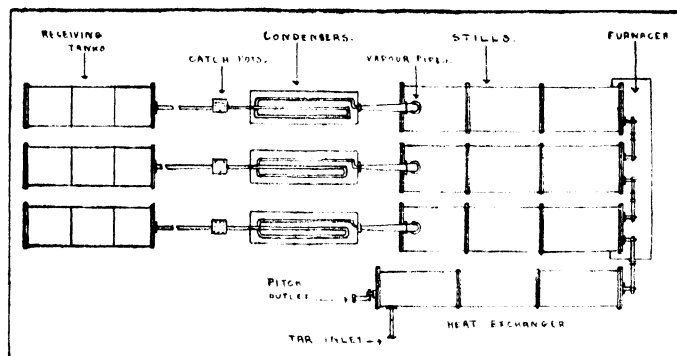


Fig. 2.—Continuous Still (Diagrammatic).

The pressed crude naphthalene and crude anthracene are then accorded special refining treatment.

The residual product from the last still, after passing through the heat exchanger, will either be run into pitch bays or to mixing tanks where it is blended with selected oils to various road tar specifications.

The most modern design of distillation equipment is the "tube still," wherein tar is pumped through a series of pipes set in an oil-fired furnace. The hot tar is then flashed into a column where the vapours are fractionated into a number of distillate "cuts" in a single operation. An increasing number of plants of this type have been installed in recent years in the U.K. and U.S.A., but to date there is none of this design in India, although several T.I.C. distillation units have been installed wherein the crude tar instead of circulating through tubes, is circulated in a thin film over a layer of molten lead. This ensures good heat transfer and minimizes coking.

By-products from Coke Oven Gas

From the flow diagram given above it will be noted that certain by-products can be obtained both from the coke oven or coal gas resulting from coal carbonization, as well as from the coal tar.

After separation of coal tar from the gas, the latter may be treated for extraction of ammonia. This is achieved by the direct process of bubbling the gas through sulphuric acid with the formation of ammonium sulphate crystals or by cooling, and scrubbing the gas with water in which the ammonia is soluble. The ammoniacal liquor is then either concentrated or distilled in order to regenerate the ammonia gas which is absorbed in sulphuric acid to yield ammonium sulphate by the indirect process.

This product is crystalline and is suitable for use, after neutralization of free acid as a fertilizer.

The average yield of ammonium sulphate in India is 25 lbs. per ton of coal coked and the pre-war production of ammonium sulphate from this source was 25,000 tons per annum approximately, but this has dropped due to shortage of coal to about 20,000 tons in 1944.

Recovery of ammonium sulphate from coke oven gas is carried out in India by:—

Bararee Coke Co., Jharia.

Burrakur Coal Co., Jharia.

E. I. Rly., Giridih.

Indian Iron and Steel Co., Hirapur.

Tata Iron and Steel Co., Ltd., Jamshedpur.

Other by-products remaining in the gas after passing various coolers and strippers consist mainly of the more volatile members of the aromatic hydro-carbon series, viz., benzene (B.P. 80° C.), toluene (B.P. 110.5° C.), xylenes (B.P. 137.5—144° C.), etc.

The terms benzole, toluole, etc., are applied to commercial products which are mixtures of aromatic hydrocarbons in which the pure hydrocarbons, benzene, toluene, etc., respectively predominate.

Coke oven gas produced from good grades of coal contains approximately 1 per cent. by volume of these condensible hydrocarbons and the yield is 3.5—4.5 gallons per ton of coal carbonized. With Indian coals, the yield of crude benzole is approximately half this figure, at 2.0 gallons per ton of coal carbonized.

In addition to the aromatic hydrocarbons, crude benzole contains small quantities of certain other condensible compounds which are normally regarded as impurities, and are, therefore, eliminated during the subsequent refining processes. First there are the sulphur containing compounds which are objectionable in motor benzole on account of their corrosive potentiality. These comprise hydrogen sulphide (H_2S), carbon disulphide (CS_2), thiophen (C_4H_4S), and various mercaptans and organic sulphides. As Indian coking coals contain comparatively very little sulphur, these compounds are only present in the crude benzole manufactured in India to a very slight extent.

Secondly, there are the unsaturated compounds which, on polymerization, form gums and resins. Of these the more important are cyclopentadiene (C_5H_6), styrene (C_8H_8), indene (C_9H_8) and cumarone (C_8H_6O). The recovery of the two latter in polymerized resinous form from the solvent naphtha fractions has been developed on a big scale in the U.K. and U.S.A. in recent years and since the present war the cyclopentadiene and styrene have also assumed much importance in the realm of "synthetics."

The extraction of the condensible compounds from the coke oven or coal gas may be effected either by (1) compression and cooling, (2) absorption in a solvent oil, (3) adsorption on activated charcoal, silica gel, etc.

The second method is the one most commonly employed whereby the gas is "scrubbed" by a suitable absorption oil circulated counter current to the gas in a packed tower or washer of special designs. The absorption oil, which may be a selected coal tar creosote fraction, or a petroleum straw or gas oil, dissolves the liquifiable

products from the gas, which are then recovered by steam distillation of the enriched absorption oil in the form of crude benzole.

The stripped absorption oil remaining as the residue from this distillation is continuously recycled for scrubbing after removal of any solid products, e.g., naphthalene, which separate on cooling.

The further treatment of the crude benzole consists of fractionation into benzole, toluole and xylene and the removal of sulphur and gum-forming compounds. The actual sequence of treatment will depend on the type of plant installed and the final products required.

It is usual first to resolve the crude benzole into three or four fractions, then to refine with strong sulphuric acid and to redistill with fractionation to the desired specifications for the individual final products.

The most important commercial products resulting from coke oven or coal gas are (1) motor benzole, (2) benzene, (3) toluene for nitration and, (4) solvent naphthas.

The condensible hydrocarbons in a coke oven gas are present in varying proportions depending on coking conditions. An average composition of these hydrocarbons in coke oven gas is as follows:—

Benzene	75
Toluene	15
Xylenes and higher homologues	10

It is not, however, common practice to extract these compounds completely. The absorption method of gas recovery is a very flexible process, and by varying the degree of saturation and the degree of stripping of the enriched absorption oil, it is possible to control the relative efficiency of extraction of the individual products. Thus, if a recovery unit is operated with over-saturated oil, recovery of toluene and xylenes will be favoured at the expense of the benzene recovery, but if a partially stripped absorption oil is employed, recovery of benzene is promoted at the expense of the toluene and xylenes.

A number of factors have, therefore, to be considered in determining the operating conditions of a particular benzol recovery unit. Complete extraction of the benzene from the gas is not likely to prove economical. Another factor is, that the removal of crude benzole from the gas causes a definite drop

of calorific value, since the calorific value of benzene vapour is seven times that of the residual gas. Complete removal of the crude benzole will, therefore, reduce the calorific value by 5 per cent. of its original value, which may not be permissible, depending on the use for which the gas is employed.

It will be realized, therefore, that the composition of crude benzole is likely to vary very considerably according to the operating conditions of any particular recovery unit.

In normal times benzole recovery is undertaken mainly for the production of motor benzole, but during war-time there develops a sudden demand for toluene for nitration to explosives (T.N.T.).

In India, motor benzole has been subjected to an excise duty equal to that on imported petrol and for this reason indigenous benzole recovery has not been an economic proposition, and up to the beginning of the present war, it received no official encouragement, as it has in the U.K. and other countries, by remission of duty.

The first Benzole Recovery Unit was installed in 1920 by *The Bararee Coke Co., Ltd.* with a capacity of 1,00,000 gallons per annum. This was soon followed by the erection of a similar plant by the *East Indian Railway* at Giridih.

For the reasons given above no other plants were installed in India until the advent of the present war when the large demand for toluene and motor fuel led to the erection of Gas Recovery Units at the two major steel works—Jamshedpur and Hirapur—by the Government of India. These Gas Recovery Units are capable of producing

27 lakhs gallons of Benzole per annum.

A revision of fiscal policy on the part of the Government of India would appear to be necessary if these plants are to operate on a commercial basis in the post-war period.

References

- 1 *U. S. Bureau of Mines, Bull.*, No. 412.
- 2 *The Constitution of Road Tar*, E. J. Dickinson, *J.S.C.I.*, 1945, 64.

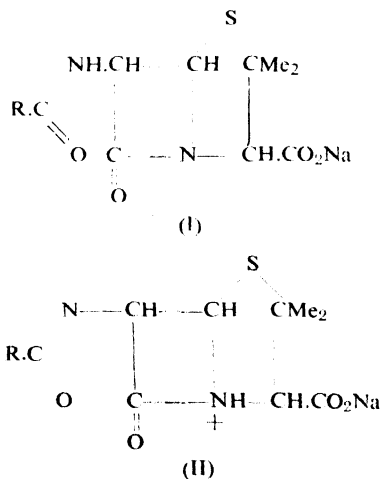
CHEMISTRY OF PENICILLIN

INTENSIVE studies on the chemistry of penicillin, in which a large number of top-ranking

British and American scientists collaborated, have yielded results of great scientific significance. The results obtained up to the end of 1944 have been published under the joint auspices of the *Committee on Medical Research* (Office of Scientific Research and Development, Washington) and the *Medical Research Council*, London. A summary of the findings has appeared in *Nature*, 1945, 156, 766.

Several antibiotics of the penicillin class with the empirical formula $C_9H_{11}O_4SN_2R$ are known. In penicillin-I, R is Δ^2 -pentaenyl; in penicillin-II, R is benzyl; in penicillin-III, R is *p*-hydroxybenzyl; and in *K*-penicillin, R is *n*-heptyl. The penicillins are strong monobasic acids of pK_a about 2.8. On treatment with hot dilute mineral acids, they afford one molecule of carbon dioxide, an amino acid termed penicillamine—*d*- β , β -dimethyl cysteine and other products. It should be noted that penicillamine belongs to the *d* or 'unnatural' group of α -amino-acids. Among the "other products" is an aldehyde of the formula $C_8H_{13}O_2N$ (Δ^2 -hexenoylamino-acetaldehyde) from penicillin-I, and an aldehyde of the formula $C_{10}H_{11}O_2N$ (phenylacetylaminocetaldehyde), phenacetic acid and phenylacetamide from penicillin-II. Penicillin-II with benzylamine gives a hydrated addition compound of 1 mol of penicillin-II and 2 of benzylamine. The penicillins are readily inactivated by methanol yielding methyl esters. They are also acted upon by diazomethane forming monomethyl esters. When any of the penicillins is held in aqueous solutions of dilute

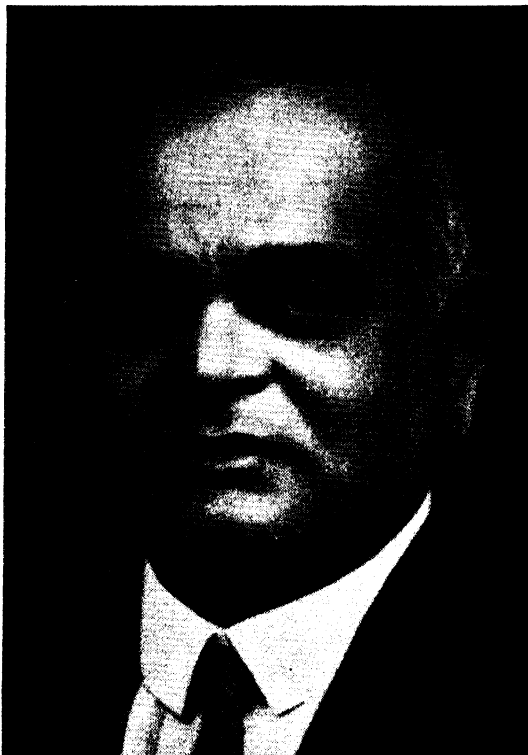
mineral acids at 30° C., it undergoes a change which can be followed polarimetrically, and crystalline dibasic acids can readily be isolated from the solutions. By the action of Raney nickel catalyst on the sodium salt of penicillin-II, desthio-penicillin-II and phenacetyl-*L*-alanyl-*D*-valine are obtained. As a result of these and a number of other reactions studied, the following two formulæ for penicillin containing a β -lactam structure (I) and an incipient azlactone grouping (II) are receiving attention.



Obituary

KAPILRAM H. VAKIL, M.Sc. (Tech.), F.R.I.C., A.M.I.Chem.E.

IT was with deep grief and sorrow that the scientific world received the news of the demise of Mr. Kapilram H. Vakil at Mithapur on the night of 28th January, 1946. Mr. Vakil was born in Surat in 1884 and had his early education at the New High School, Bombay. He then joined the Elphinstone College, Bombay, and took the Bachelor's Degree with high proficiency in physics for which he was awarded the Bell Prize. In 1909, Mr. Vakil proceeded to England and obtained the M.Sc. (Tech.) of the Manchester University as also Diplomas in several branches of Applied Chemistry. Mr. Vakil was early recognised as an expert in soaps and oils, and immediately on his return to India, he was appointed Manager and Consulting Chemist of the *Jamshed Tata Oil Mills*. It was here that Mr. Vakil realised the need and scope for developing the cottonseed oil industry in India, and evolved processes of great value to the industry. This work was soon followed by a series of original contributions on the manufacture of vegetable *ghee* from indigenous vegetable oils; the process worked out by him is being used even to this day not only in India but also in European countries. Subsequently, Mr. Vakil set up independent consulting practice in Bombay which he continued until 1916 when he was awarded the Manchester City Corporation's Special Research Scholarship to continue his researches at Manchester. On completion of this work, he was awarded the Degree of Master



of Technical Sciences of the Manchester University. He was then offered a Research Scholarship by the Privy Council to continue his researches. Simultaneously, Messrs. *Lever Brothers* and *Tata Sons Ltd.* requested him to act as their consultant chemist. Mr. Vakil accepted the latter offer and was associated with the *Tatas* till his death. Mr. Vakil visited Europe and America over a dozen times to keep himself in touch with the latest advances both in technical processes and in plant design. During this period, Mr. Vakil found

time to investigate and successfully carry out a project for the manufacture of alkalies in Dhrangadhra State, and thus became a pioneer in establishing a key industry in India. He was actively associated with the reconstruction of the magnesium chloride plant of the *Pioneer Magnesia Works* at Kharaghoda and the *Okha Salt Works*. Just ten years back, Mr. Kapilram Vakil established at Mithapur under the auspices of the *Tatas*, the largest marine chemical plant in India and remained its Technical Director till his death. It was but fitting that Mr. Vakil should have breathed his last at the Mithapur Works, a place which would not have seen the light of day but for his great perseverance, technical ability and keen foresight.

Mr. Vakil was held in high esteem by scientists in India for his professional ability. He was actively associated with a large

(Continued on page 481)

REVIEWS

Lubricating and Allied Oils. By E. A. EVANS (Chapman & Hall, London), III Edition, 1945. Pp. ix+210. Price 15s.

THE publication of the third revised edition of this book is most welcome, for it appears at a time when war-time restrictions have led to the withholding of a great deal of information on technical and scientific advances. The author has endeavoured to bring the subject matter of the book up-to-date consistent with these restrictions.

The book was originally written in a "non-too-technical" manner, for the use of such chemists and engineers, who were themselves not specialists in the subject of lubrication. This end has been kept in view in this revised and completely rewritten edition. But in so doing the author has at times overlooked certain fundamental needs of a non-specialist, who must be introduced to a new term or a new concept in a logical sequence of subject development. For instance, "viscosity index" has been discussed before an attempt is made to define it; discussion on boundary friction is introduced before taking up the more easily understood concept of film lubrication. Similarly, sub-heads in certain chapters, such as "Tests" and "Oils Employed," could be more logically grouped. For example, tests could be grouped into "Chemical," "Physico-chemical," "Electrical," etc.; oils employed could also be grouped similarly under "Lubricants," "Electrical Oils," "Cooling and Heating Media," etc. Such an arrangement, it is admitted, will hardly improve the intrinsic value of the treatment as given, which is admittedly masterful, penetrating and to the point, but a general classification always helps the uninitiated mind to properly docket the vast amount of information in a manner more readily accessible when required.

Presentation of some of the electrical material, such as "power factor," is apt to mislead the uninitiated or at least make it difficult for him to fully comprehend the trend of the author's thought. For instance, at one point a high power factor is said to be desirable, without explaining under what circumstances, and immediately in the following paragraph low power factor is called for insulators (pp. 103-4). Similarly, the

word "current" is employed in places where "voltage" is meant (p. 87). Furthermore, it would have been useful to explain the relationship between power factor and resistivity, since merely the statement that oils of "high resistivity will produce cables of very low power factors," hardly meets the needs of a chemist, for instance, and to an electrical engineer it is more in the nature of a truism.

The new chapter on fatty oils is most welcome, for this subject has hardly received adequate attention at the hands of lubrication specialists. In fact the author himself does not appear to be acquainted with the fundamental and applied work done in India on the utilization of vegetable oils in internal combustion engines (*Indian Industrial Research Bulletins*, Nos. 18 and 20, 1942; *Indian Patent No.* 27715, 1940), which deals with the question of addition agents for preventing oxidation and polymerization of vegetable oils and their utilization in blends of varying viscosity suitable for different types of engines. As a result of this work, it has been established that castor oil is particularly amenable to stabilization and should, therefore, find a much greater field of application in view of its other qualities, viz., low coefficient of friction, high film strength, high viscosity index, etc. The author's remarks regarding this oil, on p. 85 and p. 185 could, therefore, be usefully amended. Similarly the remark on p. 66 that "so far there does not appear to be any means for checking the development (of acidity) in fatty oils . . ." could be modified.

These researches in India have further demonstrated the inadequacy of oxidation tests as applied to engine lubricants and the author would have found substantial support in this work for his views expressed on p. 187. A mineral oil blend of reputable make gave a viscosity increase ratio of 1.1 in a modified Air Ministry Oxidation Test and 1.26 in engine trial, while a 100 per cent. vegetable oil blend gave corresponding ratios of 5.5 and 1.17. Clearly, therefore, a comparison of these two widely different lubricants could hardly be made on the basis of oxidation tests—engine tests furnish the only reliable answer.

The value of the book could have been further enhanced, if a liberal number of references to original literature was included. Unfortunately the number of references has been pitifully reduced in this new edition as compared with the earlier editions. The book on the whole is highly readable and contains a vast store of information on the subject including some of the most recent advances. Besides its usefulness to the engineers and chemists, it would prove highly valuable as a guide to all students of lubricating science, and should, therefore, find a place in all technological libraries. Besides the most interesting historical account given in an early chapter, the author has endeavoured to give historical background of various other aspects of the subject in subsequent chapters. Of particular interest are his revelations regarding the history of wire drawing lubricants on p. 200.

In the last chapter, "Oils Employed," which should be of the greatest interest to practical engineers, the author has dealt with characteristic applications of oils not only to lubricating problems, but also for such purposes as heating and cooling media, in thermostats, for metal quenching, tempering and cutting fluids; and as electrical insulator in cables and transformers. A word about hydraulic fluids such as those used in brake mechanisms and hydraulic power transmissions could also find a useful place in this chapter.

LAL C. VERMAN.

The Mineral Resources of Rewa State and their Development and Utilization. By SIR CYRIL S. FOX (Department of Commerce and Industries, Rewa State, Central India), 1945. Pp. iv + 85. Price, Rs. 3-8-0.

The report is, in the words of the author, the "Mineral Audit" of the Rewa State and is the outcome of his 16 days' tour in the State in May 1945. About 14 pages in the report are devoted to a brief sketch of the geology of the State, 20 pages to a short description of the mineral deposits, 14 pages to mineral industries, 7 pages to water supplies and the rest to the author's various recommendations.

The most important minerals of Rewa State are bauxite, coal, corundum, limestone and sillimanite, although baryte, copper ore, dolomite, glass sands, gypsum, iron ores, ochres, etc., also occur in small amounts. The author does not favour the erection of any works for the manufacture of aluminium

from the bauxite of Amarkantak plateau unless it be in conjunction with the *Aluminium Company of Calcutta*, but he recommends that works may be erected for the extraction of aluminium hydroxide or for the preparation of various aluminous compounds. Artificial emery may also be produced by fusing certain types of aluminous laterite of this plateau to give an aluminous slag which may be crushed and sieved like emery. A small abrasives factory can also be erected near Pipra to utilize the corundum deposit for the manufacture of papers, cloth and wheels for grinding and polishing.

The coal-fields of Rewa State—Singrauli, Korar, Umaria and Sohagpur—still require detailed mapping and prospecting to prove their extensions and reserves. The author suggests that the quality of the coals of the Rewa Coalfields can be improved by drying. Rewa State possesses large reserves of good quality limestone and there are good prospects of Portland cement manufacture in the State. The author further suggests that as a subsidiary to this industry, the production of high alumina cements can be successfully and profitably undertaken in the State as bauxite or aluminous laterite is locally available. Gypsum for the manufacture of plaster of Paris is also available in the State. High grade lime and carbon dioxide (for use in solid form, "dry ice," for refrigeration purposes) can also be made from the limestone. There are prospects for starting a refractory works utilizing sillimanite of Pipra and quartz from Lorhi and fire-clay found around Chandia, and also for a small glass factory using glass sand from Akauria, Khandu and Majhiyari. For the supply of cheap electric power, the author suggests that a great power station may be established in the coalfield at Umaria or near Anuppur, using cheap coal available locally. Amongst the general recommendations are suggestions for opening of new motor and rail roads, the establishment of a Mines Department, revision of mining rules and the formation of a Rewa Minerals Exploration Company to carry out a thorough examination of the mineral occurrences of the Rewa State.

Many papers on the mineral deposits of Rewa State have appeared in the *Records* and *Memoirs* of the *Geological Survey of India*, and several bulletins on individual minerals have been published by Mr. K. P. Sinor who was State geologist of the Rewa State for many years. Mr. Sinor has also published a book on the *Mineral Resources of Rewa*

State. One should not, therefore, expect any original findings or mineral discoveries in the pamphlet under review, especially as the author's aim was to prepare only a "Mineral Audit" for the State during his hurried visit. The information in case of certain minerals is rather incomplete. The reviewer knows that Dr. V. S. Dubey of the *Benares Hindu University* had carried out some important investigations on the gypsum and baryte deposits of the State but these minerals are rather summarily dealt with by the author. On the whole, Sir Cyril Fox gives us in this report, in his characteristic masterly style, what is so far known about the Rewa minerals and has suggested the ways in which the mineral wealth can be exploited.

N. L. S.

A Handbook of Empire Timbers. Edited by H. A. Cox, M.A. (His Majesty's Stationery Office, London), 1939. Pp. vii+214. Price 3s. 6d.

This book gives a brief account of some 90 species of timbers of the British Empire. In a prefatory note, Mr. W. A. Robertson of the *Forest Products Research Laboratory*, Princes Risborough, explains that the volume under review contains "up-to-date information on the Empire timbers now being offered in the home market—", and is a sequel to "A Handbook of Empire Timbers" issued by the *Empire Marketing Board* in 1932.

The book opens with an introduction giving explanatory notes and significance of the several expressions used in the following sections—such as weights of timbers, shrinkage figures, bending properties, strength properties, resistance to attack by fungi, insect attack and susceptibility to marine borers, permeability and woodworking qualities. The general plan is to describe these properties of individual timbers in a semi-quantitative manner—for example, the resistance to attack by fungi being referred to as "very resistant," "resistant," and so on, leading to "perishable," the connotation of each of these terms being explained in the introduction. There are two appendices; Appendix A consists of eight different schedules for seasoning timber; and Appendix B tabulates the mechanical properties of the timbers dealt with, in their green and air-dry conditions.

The book would appear to be planned mainly for the use of those who are engaged in or familiar with the usages of the British timber trade. Thus, the timbers are listed

(but not numbered) in the alphabetical order not of their Latin names but of their trade names in the British market. And quite often such expressions as (p. 139) "the wood (viz., Indian Rosewood) is botanically related to Cocobolo" does not convey much meaning to the general reader, especially as the botanical name of "Cocobolo" is not stated and neither is "Cocobolo" separately dealt with in the volume. Under the heading "supplies" such expressions as, for example, p. 154, with reference to teak, "sufficient to meet any demands likely to arise in this country" hardly conveys to the average reader any idea of the normal teak exports from India to Great Britain. It is to be regretted that *Baikioea plurijuga* is listed as "Teak, Rhodesian," although a footnote hastens to explain "Not to be confused with true teak (*Tectona grandis*), see page 152." Why then perpetuate this confusion? The Editor in his introduction says that "The common names used are in accordance with the list prepared by the Trades Names Committee of the *Empire Forestry Association*." But, even then, publications such as the one under review could render a real service to the trade by helping to bring into usage the *local* name of the timber instead of acquiescing to the use of geographical appellations such as "Rhodesian Teak" which admittedly is not teak. The book does not include data on the fire-resistance of wood. And, it is a tribute to the remarkable advances made recently in timber technology that so late as 1939 (the year of publication of this volume) the technique of bending wood with the aid of urea solutions and the resin impregnation of timbers were not yet developed. And the very long way that we have traversed since 1939 is also impressively brought home in that the first use listed for Balsa (*Ochroma Sp.*) on p. 23, is "For Model and Toy aeroplanes—"!

A Handbook of Empire Timbers is a convenient book of reference to those who are conversant with the British timber trade. The technical and scientific reader would perhaps wish for more quantitative data. He would certainly like that the sources of data (p. 209) were not confined to a list of 13 institutions but a full bibliography. Such a supplement in a future edition would very greatly enlarge the usefulness of this volume without interfering with the convenience of the timber tradesman for whose use the present volume is well suited.

Reports from States and Provinces

Madras

THE occurrence of magnesite and mica has been noticed in certain villages of Namakkal Taluk, Salem District, by the Geological Survey of India in the course of their investigations during the 1943-44 field season, states a Madras Government Press Note.

Magnesite has been reported in the following localities: (i) The low hillocks locally called Sunnam-bukkaradu, about 4 furlongs east of the Jangamanayakanpatti village; (ii) about 3 furlongs north of Puliampatti village; (iii) in a high ground north-east of Vimanayakanur; (iv) about 500 yards north-east of Kuppampalaiyam village; (v) south of the hillock to the north of Vellaikkalpatti village; (vi) north-north-west and north-west of Varappalaiyam village and along the Kirambur-Tanduvadam-palaiyam track; (vii) in a well roughly two furlongs N.N.W. of Tokkadempalaiyam, and (viii) on the top of Tolorkaradu hill.

The mineral is reported to occur in thin veins only. The analysis of the samples has shown that but for the large percentage of lime, the mineral is fairly good. Samples taken from deeper zones may be of purer quality.

Mica has been reported in the following places: (i) a well to the west of Kallangattupudur village; (ii) two and a half furlongs to the north-west of Silvapatti village; (iii) about a mile to the west of Nallakavundanpalaiyam village; (iv) in the high ground south of Tattarapalaiyam village; (v) about a furlong and a half W.N.W. of Udaynpur, and (vi) at a furlong to the N.N.E. of the village Murtipatti.

Bengal

The Bengal Industrial Research Board which was established in 1938 was reconstituted in 1944. The Hon'ble Minister-in-charge of Commerce, Labour and Industries Department, is the ex-officio Chairman. Its main functions are:—

- (i) to advise the Industries Department in matters relating to industrial research, to co-ordinate existing work and to indicate new lines of research;
- (ii) to advise the Industries Department where particular lines of industrial research can best be carried out and endeavour to secure the active co-operation of the universities and technical institutions;
- (iii) to examine all proposals for industrial research whether in Government institutions or outside, submitted by the Industries Department and to advise on their merits;
- (iv) to review reports of industrial research undertaken by Government in its own institutions or with financial help from Government in other institutions, and to advise the Industries Department on the continuance of such work;
- (v) to form liaison with the Board of Scientific and Industrial Research under the Government of India, and to bring to its notice problems of research that may arise or be taken up in Bengal.

A large number of research schemes have been taken up for investigation. The following schemes have

been successfully completed:—(1) Analysis and determination of physical characteristics of well-known soaps; (2) preparation of sand paper; (3) examination of Indian tanning materials with reference to ink manufacture; (4) preparation of casein and lactose from milk; (5) indigenous anti-septics, their preparation and use in sizing mixtures applied to textiles; (6) dextrines from potato, maize, rice and other minor starches; (7) design and construction of components for radio reception and radio transmission; (8) splitting of oils and fats; (9) production of malt; (10) fermentative production of citric, oxalic and gluconic acids; (11) hypo salts; (12) manufacture of printing types by electrodeposition and casting process; (13) manufacture of electric bells; (14) starch dextrine and other kinds of industrial adhesives; (15) possibilities of utilizing Gurjan oil as a source of natural varnish; (16) investigations into drying oils other than linseed oil; (17) development of modern electroplating process in Bengal.

The following schemes are under investigation:—(1) Design and manufacture of measuring instruments (Calcutta University); (2) design and manufacture of radio components (Calcutta University); (3) phosphoric acid (Calcutta University); (4) utilization of horn waste (Dacca University); (5) commercial possibilities of fish oil; and (6) problem of fading of paints and varnishes on storage in different containers and media (Industrial Research Laboratory).

The researches that have been completed are awaiting practical utilization. The Technical Sub-Committee of the Board will shortly take up the matter and explore possibilities of their utilization by private industrialists on mutually agreed terms and conditions.

A sum of Rs. 35,000 is made available to the Board every year for financing research schemes.

Rajputana States

Reconstruction Schemes

"The new universally prevalent and widely accepted demand for planned development of India's industrial and economic resources has not left the Rajputana States unaffected," said Rai Sahib Kishan Puri, Secretary, Post-war Reconstruction Department, Jodhpur State, in a broadcast talk from *All India Radio, Delhi*, on 15th December 1945.

The Jaipur Government has prepared a five-year plan for a better Jaipur. Its total capital cost will amount to nearly Rs. 9 crores and the recurring cost to about Rs. 1,18,00,000. Out of the capital cost, nearly Rs. 4 crores are for hydro-electric and big irrigation projects and a little over a crore for the extension of the railway system. Construction of wells and smaller tanks, distribution of improved seeds, implements and manures, improvement of live-stock will account for another Rs. 30 lakhs. Introduction and improvement of rural and cottage industries through the establishment of engineering schools, a technical institute, demonstration parties and investments in heavy or large-scale medium industries will claim about Rs. 30 lakhs. For higher education, a medical college, an engineering college, an agricultural college, a women's degree college and a University will be established.

The Jodhpur Government had earmarked a sum of Rs. 4 crores for post-war schemes. The Jawai irrigation-cum-hydro-electric project is estimated to cost over a crore of rupees. The area commanded by irrigation will be 230,700 acres. The Jodhpur Railway has a programme of extension and other works are estimated to cost over a crore of rupees. Factories for the manufacture of heavy chemicals, cement and dyestuffs have also been proposed.

The most important scheme of the Bikaner State is the Bhakra Dam in which the Punjab Government and some other States are partners. The Bikaner State's share of the cost is estimated to be Rs. 6 crores. The project will irrigate about 2,000 square miles. Agriculture and animal husbandry occupy a prominent place in Bikaner State's planning.

The Udaipur Government has under consideration a big hydro-electric project on the Chambal, which is being examined by experts. It has also a five-year road programme at an estimated cost of Rs. 25 lakhs, a major irrigation scheme on the Banas River and railway extension schemes are estimated to cost over three crores of rupees.

The Bundi State proposes to bring an area of 100,000 acres under cultivation and to start an agricultural farm at each tehsil headquarter. A vigorous afforestation policy is to be followed by enforcing stricter forest laws and replanting denuded and barren areas. The Tonk and Shahpura States have earmarked Rs. 20 lakhs and Rs. 32 lakhs respectively for Reconstruction Schemes. The construction of Chandraver Sagar Dam is one of the items of Banswara post-war development plans. Agricultural development, electrification of urban as well as rural areas, establishment of textile and other industries and expansion of primary education are amongst items included in the Palanpur State five-year Reconstruction Scheme.

Mysore

The Government Porcelain Factory, Bangalore, is located in a spacious plot of land, opposite to the

Indian Institute of Science. The factory which commenced operation in March, 1942, is owned by the Government of His Highness the Maharaja of Mysore.

The factory obtains the raw materials required, such as kaolin, felspar, etc., locally. It is provided with three coal-fired kilns and one electric tunnel kiln. The latter which was installed three years ago, is the first of its kind in Asia and the fifth in the world. A laboratory is attached to the factory for testing raw and processed materials and arrangements exist for sorting and testing all the wares made.

The factory now manufactures all types of electro-porcelain articles of low and high tensions, acid jars, glazed wall tiles, chemical porcelain such as crucibles and evaporating dishes, domestic crockery ware, fancy articles, porcelain heater bases, plaster of Paris, etc.

Further expansion on the manufacturing side is at present receiving the attention of Government so as to enable the factory to cope with the increased demand that would arise for electro-porcelain as a result of the several hydro-electric schemes likely to come into operation in the country in the near future, and for crockery articles.—(Contributed.)

Holkar State, Indore

Central Arts and Crafts Emporium

With a view to encourage the cottage industries in the State, His Highness' Government recently sanctioned the establishment of a Central Arts and Crafts Emporium. It is situated in the heart of Indore City, and in it are displayed, both for sale and exhibition, products of the famous Maheshwar handloom industry, and of the Government Weaving and Dyeing Demonstration Factory, Maheshwar. Blankets of attractive designs from local wool, the products of Manasa, are also on show. Prominent among the exhibits are the artistic toys produced in Indore.—(Contributed.)

Obituary—KAPILRAM H. VAKIL

(Continued from page 476)

number of institutions, committees, both official and non-official. He was a member of the Heavy Chemicals and Chemical Industries Committee and the Electro-Chemical Industries Committee of the Board of Scientific and Industrial Research.

Mr. Kapilram Vakil invented and patented several processes for refining oils and fats, one of which, relating to the refining of fish oils, is now in operation in the U. S. A., Spain and the Netherlands. Mr. Vakil published several memoirs on chemical and industrial problems facing the Indian manufacturer, and his monographs on *Indian*

Coal and its By-products, Salt, etc., are widely known.

Mr. Vakil was not enjoying good health for some time past. His visits to Mithapur, particularly during the last year, were few, and they were undertaken only when permitted by his doctors. When he learnt that a prominent visitor was coming to the Mithapur Works, he hastened there in spite of protests from the members of his family and medical attendants. He had to pay heavily for this. A true savant and a devotee, Mr. Vakil dedicated his life to the cause of the development of scientific industries in India, and he breathed his last in surroundings of his own creation. M. P.

NOTES AND NEWS

Fuel Economy Discussions

A SERIES of lectures and discussions on fuel economy in chemical industry have been published in *Chemical Age*. In view of the importance of this subject, a brief summary of the more important aspects of the subject are given below:—

Lime-Soda Softening Process

The normal lime-soda water softening process carried out in the cold is a slow one. The expedients employed to speed up the process are heating the incoming water, use of lime and soda in excess and addition of coagulants such as alumina-ferric. If the process could be speeded up in the cold there will evidently be saving in fuel.

The slowness of the orthodox process is attributed to the attempt at simultaneous removal by precipitation of magnesium hydroxide and calcium carbonate. The former is amorphous and would blanket and prevent the growth of crystals of the latter. Moreover, each of them has its own optimum pH. value for ready separation. A new method in two stages has been proposed. In the first stage, lime equivalent to the sum of temporary hardness and magnesium hardness + an excess equal to 100 parts per million at CaCO_3 is added. After the scheduled time for reaction and filtration, the water is tested for alkalinity and treated with the required amount of sodium bicarbonate and soda. In both stages by stirring the water with paper pulp and drawing off by gravity through the filter mat formed by settling, complete separation could be effected in 10 minutes. The residual hardness of the samples of water by this process which takes half an hour including cleaning, etc., was 27 parts, whereas by the ordinary process it was 200 parts after an hour, and 100 parts after 2 hours. The process which has not yet come to the pilot plant stage is being patented. (*Chem. Age*, 1945, 52, 139.)

Boiler House Instruments and Automatic Control

With the increase in size and complexity of boilers, more instruments have become necessary and considerable development in their design and fabrication has taken place. The chief instruments to be considered are gauge glasses, pressure gauges, steam and water metres, temperature measuring instruments of various types, gas analysis and smoke density instruments.

Factors requiring adjustment are (1) supply of water, (2) supply and distribution of fuel, (3) supply and distribution of air for combustion, (4) combustion chamber draught (in balanced draught system), and (5) superheat. Of these the first is now generally subject to automatic control. The combustion chamber draught is easily adjusted by automatic control and so also superheat. With liquid and gaseous fuels or pulverised fuels in suspension, automatic control is quite easy. The difficulty is in the case of solid fuels burning on a grate. Owing to the large mass of fuel burning on the grate at any one time, variations in the rate of fuel feed make themselves felt slowly. The control of air is of the utmost importance in such cases and this is best carried out with the aid of a CO_2 recorder, Continu-

ous recording of $\text{CO} + \text{H}_2$ content though useful is not considered justifiable in view of the cost of instruments which need to have a high standard of accuracy to show properly the small $\text{CO} + \text{H}_2$ content. In automatic pressure control, supplies of fuel and air are varied by steam pressure variations keeping a constant ratio of fuel to air subject to subsidiary control which varies the ratio.

Automatic control gives consistent results but it does not restrict the opportunity of combustion engineers to apply their skill and experience. (*Chem. Age*, 1945, 52, 419.)

Simultaneous Generation of Power and Process Steam

In steam power plants the exhaust loss is by far the greatest single loss. This is an inevitable cycle loss and may amount to about 65 per cent. of the boiler heat input in a high-grade condensing station and may be as much as 85 to 90 per cent. in a locomotive or colliery engine. This cycle loss disappears if the cycle is modified so as to use the heat in the exhaust steam. By combining power generation with exhaust heating, not only the cycle loss but also losses due to such causes as wire drawing of steam, cylinder condensation, valve leakage and piston leakage in steam engines and tip and inter-stage leakage and blade friction in steam turbines, all of which are dead losses to the pure power generator, are captured. "From the national coal conservation point of view it is almost impossible to have such a bad engine that power cannot be generated for less heat than by the finest power station, provided all the exhaust steam can be economically used." For costing the power it is necessary to know the amount of heat to be debited to the machine. For this purpose fairly reliable exhaust calorimetry is required. (*Chem. Age*, 1945, 53, 125.)

Inhibition of Metal Corrosion

In considering electrolytic corrosion, the points to remember are: (1) Water is the universal solvent and is never found in nature in the pure state, and (2) no metal is entirely insoluble in water. In this type of corrosion two reactions take place simultaneously. Somewhere in the system, metal is dissolved at the anodes and hydrogen is evolved at the cathodes. The electrode potential varies from metal to metal and even for the same metal, the potential depends on the concentration of ions. The presence of oxides on the surface of the metal also affects the E.M.F. In any particular case the problem is further complicated by such factors as plant layout and comparative effectiveness of trapping of steam lines, occurrence of dew point temperatures, etc., so that it is difficult to say which particular corrosion mechanism is responsible. Some general suggestions are made to inhibit corrosion.

In cooling and heating systems, acidity due to atmospheric pollution must be corrected by caustic soda. In closed systems air in-leakage must be prevented, water de-aerated by using chemicals, e.g., sodium sulphide, and the pH. value must be kept up, the value depending on the metal used for fabrication. In boiler feed water lines raising of pH. value

and addition of tannins if necessary are recommended. In economizer tubes besides raising pH. values and adding tannins, de-aeration may also be necessary. In boilers pH. values must be kept above 9.6, metal surfaces must be free from deposits and the water must be de-aerated. In steam and condensate lines, boiler foaming and carry over of solids must be avoided and removal of carbon dioxide and oxygen from the boiler water and proper trapping of the steam pipes, etc., must be carried out. (*Chem. Age*, 1945, 53, 215)

K. A. N.

Instrument Jewels and Pivots

The *British Electrical and Allied Industries Research Association*, London, has recently issued two valuable reports—TT/31 and TT/39—incorporating the results of researches on instrument jewels and bearings by Mr. Shotter. By his extensive and patient researches on meter and instrument jewels and pivots, and by establishing, beyond doubt, the factors that determine the life of a meter and the stability of its performance, Mr. Shotter has rendered yeoman service. The moving system consisting of the steel pivot and the sapphire jewel bearing is the most prone to wear in an instrument, and the life of the bearing is determined by the proper choice of the jewel, as regards its size, shape and orientation with respect to its optic axis. Mr. Shotter has confirmed the need for the judicious lubrication of the bearing with a suitable oil, for which he found the *Pennsylvanian Meter Oil No. 2* to be the best. It is shown that insufficient care in the use of either the quantity or the quality of the lubricant impairs the life and the reliability of the meter. Though it is found that with a jewel bearing oriented nearly 90° with respect to the optic axis, lubrication can altogether be dispensed with, it is always safe to lubricate, as no manufacturer of an electrical meter can guarantee the correctness of a mounting. A study is made of the relative advantages of the ball and pivot type of bearings, but nothing confirmatory is established under practical working conditions, though theoretically, the ball bearing is preferable. With regard to substitutes in place of steel pivots and sapphire bearings, it has been shown that materials so far tried by Mr. Shotter are in no way superior. Steel and sapphire, the materials generally in use, are easily available and they can be easily manufactured. These conclusions are also valid for bearings used in instruments other than electrical meters.

Mr. Shotter's investigations are comprehensive and thorough in every respect, and are valuable to manufacturers of electrical meters in particular, and of scientific instruments in general. They are also of value to the research worker because on the proper maintenance of the scientific instruments (with bearings) depends the precision and reliability of his results.

I. R. R.

Molasses for Road Surfacing

A composition suitable for road surfacing has been prepared by converting molasses into a resinous product with coal tar and asphalt. Products of various consistencies—hard, semi-paste and liquid—were tested in the *Ordnance Laboratory, Cawnpore*. Roads made with this composition have stood rains and heavy traffic satisfactorily. A test patch in one of the busiest thoroughfares remained unimpaired for three to four years, requiring only minor repairs.

Cotton Cultivation in Ceded Districts

A scheme of cotton cultivation (*Cambodia* breeding) to suit the black soils of the Ceded Districts in the Madras Presidency, has been drawn up. Preliminary work done at the *Agricultural Research Station, Siraguppa*, has yielded a fair medium quality strain, viz., *Hyderabad 11*. Its chief characteristics are freedom from serious pests and diseases, ability to withstand high moisture in the seedling stage, resistance to drought in late stages, medium staple length of 24 mm., fair ginning of 33 per cent., and wide adaptability over a range of soils and seasons.

"Barky" Jute Fibre

One of the commonest and most serious defects in jute is "rooty" or "barky" fibre, caused by the development of the periderm (outer bark) in the plant. The formation of the latter begins when the plant is four to six weeks old and continues till the pods are mature. The periderm continues to extend even when the plant ceases to grow. This suggests the possibility of eliminating "roots" to some extent at least, by so timing the harvest, that while there is no loss in yield, a considerable development of periderm is avoided. These are among the conclusions that emerge from the important matters reviewed in the Annual Report of the Indian Central Jute Committee for 1944-45, in the section dealing with the agricultural research activities of the Committee.

Further studies on the structure of the jute fibre in relation to quality, confirmed the earlier finding that larger ultimate fibres are generally associated with better quality.

Two species of *Wooly Aphis*, a pest, were observed on jute towards the end of the season 1944-45. This is the first record of this pest on jute. The latter attacks the stem, petiole and pods. Attack on the stem leads to the fibre, at these points, forming a hard mass with bits of the bark sticking, and the fibre bundles resisting separation. The attacked pod gets deformed and remains undersized. Preliminary studies on the life history of one of the species (white in colour) were carried out during the period under review.

New Uses for Jute

On the technological research side progress has been made in efforts to create a demand for jute twine for parcel-tying and various domestic uses. It is considered that there are considerable possibilities in a good-quality twine offered at an attractive price, the jute twine available in the bazaar being usually low in quality and the price far too high.

It has been found that teased jute cuttings make a suitable heat-insulating material for Army Nissen huts. When packed between the two layers of corrugated iron in the roof, it is as efficient as external thatching.

Replies received by the *Indian Central Jute Committee* regarding results obtained with softened jute ply-yarns sent to a number of missions, etc., indicate that there are possibilities in jute for knitting jerseys, scarves, etc.

Spray Irrigation

Spray irrigation (which has been introduced in California and other States in the U.S.A. and in Australia) is to be tried in India. By this method water is sprayed over the fields from wells and canals through water-pumping machines. It is meant to wet the entire plant instead of leaving the upper part dry, as happens when other methods of

irrigation are adopted. The Crops and Soils Wing of the *Board of Agriculture and Animal Husbandry*, at its meeting on 19th December in New Delhi, recommended to Provinces and States to undertake spray irrigation on an experimental basis. The *Imperial Council of Agricultural Research* will also study the problem.

To make the best possible use of the available water-supply, the *Board* recommended the sale of water by volume on a contractual basis. The results obtained from "flood water farming" experiments are also to be brought to the attention of Provinces and States. Flood water which accumulates in the rainy season will be spread over fields to keep them moist during the dry season.

Bureau of Plant Introduction and Exploration

The recent advances in the technique of plant breeding and seed multiplication and the scope for their economic utilization were also considered. The *Board* recommended that the Government of India should immediately set up a Bureau of Plant Introduction and Exploration. The Bureau will collect various species of plants by organizing expeditions to selected areas both within and outside India, and by correspondence and exchange with other countries.

Oil Spray or Mist Lubrication

Oil spray or mist lubrication which has recently received the attention of U.S. lubricating engineers, is a development which has accompanied the expansion of the ball and roller bearing industry. It was first used in connection with high-speed wood-working and machine tool spindle bearings. Oil spray and mist lubrication are actually two distinct methods, although the final results are the same. Oil spray lubrication is obtained through the design of the bearing itself, flingers being provided on a ring or collar which dips into an oil bath. The oil is broken up into a mist or spray by the rotating of the bearing. In mist lubrication, low-pressure air and an external lubricator are usually employed to obtain an atomized mist of oil around the bearing surfaces. This type of lubrication is most effective in keeping down power consumption and an excessive rise in bearing temperature.—Brewer, *Machinery*, Aug. 1945; *U.S.I.S., Mech. & Elec. Eng. Newsletter*, No. 13.

Silicon Impregnation of Steel

A method of impregnating the surface of iron and steel with silicon is now in commercial use in the United States under the trade name "Ihrigizing." Its advantage is that of imparting to the steel resistance to corrosion, heat and wear. The materials capable of treatment include all types of wrought or cast steel with low carbon and low sulphur content. The medium-carbon steels can be impregnated also, but require considerably greater time; high-sulphur steels of the free machining type, and gray cast irons, because of their sulphur content, are not suitable for impregnation, as the corrosion resistance is unsatisfactory. Generally, alloy steels are not so well suited to the process as straight carbon steels. The metal is cleaned and subjected to the action of silicon carbide and chlorine at temperatures of 1,700° to 1,850° F. (930° to 1,010° C.). Ferro-silicon or mixtures of ferro-silicon and silicon carbide may be used for the purpose. Ordinary carburizing equipment is used with slight modifications, and the chlorine is added when the parts are up to heat. The exact reaction is not known, but the result is to impregnate the surface

of the metal with silicon, the depth ranging from 0.005" to 0.1" according to the time of exposure. The carbon in the silicon-impregnated portion is pushed back into the body of the metal, becoming concentrated underneath the silicon case. Analyses show that the silicon content at the surface runs as high as 14 per cent. Unlike the carbon in carburized steel, however, the silicon content is almost constant through the depth of the case. The treatment makes the metal exceptionally resistant to corrosion, heat and wear. A cut-off section of treated steel has been boiled in dilute nitric acid until the entire core was eaten away and only the siliconized case left. The surface of treated parts show a Rockwell hardness of from B-80 to B-85.—(Black, *Machinery*, Aug. 1945; *U.S.I.S., Min. & Met. Eng. Newsletter*, No. 14.)

"New Way" Butter Making

A new process for making butter, developed in Australia, has some marked advantages over the traditional methods. Known as the "New Way," the patent is the property of a machinery firm in Melbourne (Victoria), which is now taking steps to dispose of international rights to manufacturers of dairying machinery in other countries.

The butter is made without the usual churning process. The units of the machinery comprise a storage and standardizing vat, an extruder, in which the change from cream to butter takes place, a pat moulder for forming one-pound and half-pound prints and a box moulder for making 56-pound cubes.

In the new process, the milk is centrifuged in the usual way to obtain a cream of about 40 per cent. fat. The cream is immediately passed through a pasteurizer and heated to the usual flash pasteurizing temperature. It is then cooled to 140° F. and passed through a power separator to produce cream containing 80 per cent. fat, which is delivered into a float valve chamber from which it is drawn by a vacuum into a storage and standardizing vessel. The actual change from cream into butter takes place by extensive chilling and pressure in the course of its movement through the chiller and extruder. It enters the chiller and extrudes in a fluid form at a temperature of from 110 to 130° F. The finished butter is extruded at the moulding end in prints or cubes.

As the manufacturing process is completed in an enclosed all-metal plant, the butter produced has a very low bacteria count. While ordinary manufactured butter contains up to 10 per cent. of air, the "New Way" process reduces the percentage to less than one.

Research in Agriculture and Animal Husbandry

Research Institutes and Experimental Stations in respect of rice, potatoes, vegetables, fruits, grasslands and fish, will be set up in the near future. The Dairy Institute, the Veterinary Institute, the Agricultural Institute and the Forest Institute will also be expanded and financial sanction for the new institutes and for the expansion of the existing ones has been obtained. Further it is proposed to establish an agricultural college and an animal husbandry college to meet the needs of Provinces and States and to provide for post-graduate education. This was revealed by the Hon'ble Sir Jogendra Singh, Member for Agriculture, in the course of his address to the sixth meeting of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry, held in New Delhi on 17th December 1945.

Ordnance Factories for Civilian Goods

The Government of India consider it necessary, as a temporary measure, to make a fuller use of the capacity of Ordnance Factories for the manufacture of those civil articles for which their plant and machinery can be utilized without extensive re-tooling.

Before and during the war the number and size of India's Ordnance Factories increased considerably and much modern plant and machinery was installed. The rapid collapse of Japan naturally entailed a substantial reduction in the output of munitions. To obviate unemployment, the Ordnance Factories undertook the manufacture for civilian requirements, mainly Government requirements, of a certain amount of tools, jigs, fixtures and gauges, in their finely-equipped tool-rooms, and of some miscellaneous items.

The recent decision of the Government will assist the public in obtaining items unobtainable, or not readily obtainable, from other sources. The Ordnance Factories will now be open, therefore, to undertake orders on a wider scale for articles of the type indicated, for heavy steel forgings and castings, stampings, press-work, non-ferrous metals, light and medium parts for machinery, and woodware of various descriptions.

Fruit Products Control Order

To provide for the manufacture of fruit and vegetable products under hygienic conditions and in accordance with the prescribed standards of quality, the Government of India have issued a Fruit Products Control Order devised in consultation with the Provincial Governments and fruit preserving associations. (*Press Note*, 21st December 1945.)

The standards laid down have been unanimously approved by the All-India Fruit Preservers' Association which has decided to enforce them by voluntary agreement till the order comes into force. It is hoped that as a result, the reputation of Indian fruit products may not suffer and inferior adulterated or deleterious products may not be placed on the market.

The Order provides for the licensing of manufacturers and sellers of fruit products (such as fruit juices, tomato ketchup, jams, jellies, pickles and fruits and vegetables preserved by dehydration) in British India and shall come into effect in its entirety from 1st March 1946.

The licensing officer will be the Agricultural Marketing Adviser to the Government of India or any officer authorized by him. He cannot cancel a licence of a manufacturer without consulting the Provincial Advisory Board concerned.

These Boards will consist of: (a) a scientist nominated by the Government of India who shall be the Chairman, (b) a representative of the producers, nominated by the Indian Fruit Preservers' Association, and (c) a representative of consumers nominated by the Provincial Government.

A time-limit of one month has been allowed to the manufacturers to dispose of their stocks in hand from the date of commencement of the Order.

Mineral Development Advisory Board

"The Utilization Branch of the Geological Survey of India and its Advisory Committee, which were set up in 1942 for the furtherance of the war effort, have been abolished with effect from 31st December 1945," says a Press Note dated 9th January 1946.

"Consequent on their abolition and the establishment in the Geological Survey of a Mineral Development Circle, the Government of India have decided to form an Advisory Board for advising on problems connected with the mineral development of the country.

"The following will be the members of the Board: (1) Hon'ble the Labour Member (*Chairman*), (2) two representatives of the Labour Department, (3) one representative of the P. & D. Department, (4) Mineral Adviser in the P. & D. Department, (5) Director, Geological Survey of India, (6) Director, Board of Scientific and Industrial Research, (7) Chief Inspector of Mines in India, (8) Principal, Indian School of Mines, Dhanbad, (9) the Director of the proposed National Metallurgical Laboratory, (10) the Chief Mining Engineer, Railway Board, (11) Sir Jehangir Ghandy, C.I.E., Agent, *Tata Iron and Steel Co., Ltd.* (12) Dewan Bajadur D. D. Thacker, (13) Mr. G. C. Mitter, O.B.E., Chief Assay Master, His Majesty's Mint, Bombay, and (14) Mr. Chand Mull Rajgharia. The Advisory Board is composed largely of technical experts and will, it is expected, be of considerable assistance in mineral development."

Research in Cable and Radio Communications

One of the decisions reached at the Bermuda *Telecommunication Conference* held on 22nd November 1945, under the presidency of the Hon'ble Mr. James Clement Dunn, relate to the promotion of research and development in cable and telecommunication. In view of the important strategic role which cables as well as radio play in a co-ordinated telecommunications system, and in order to secure the optimum development of the services, the conference agreed that research and development work in both cable and radio communications should be fostered and promoted. It was agreed also to recommend to the International Telecommunications Union to undertake an examination of the question of standardization of modern telecommunication methods.

It was agreed at the conference that the direct radio telegraph circuit between the United States of America and India, which was established during the war on the condition that it should be closed six months after the end of the war, should be continued as a permanent measure.

Tata Institute of Fundamental Research

The Tata Institute of Fundamental Research was declared open by H.E. Sir John Colville, Governor of Bombay, on 19th December 1945. Sir Sorab Saklatwala, in requesting the Governor to inaugurate the Institute, thanked the Government of Bombay for its help and encouragement in launching the enterprise. He envisaged a Science Institute of an all-India character in which the emphasis would be on fundamental research in physics and mathematics. Prof. Homi Bhabha, F.R.S., Director of the Institute, in the course of a brief talk stated that Cosmic Rays would form the main field of experimental research at the Institute for the present, but the scope would soon be extended to nuclear physics, since the two are really closely related.

Prof. Chandrasekhar, F.R.S., is expected to join the staff of the Institute shortly. Prof. D. D. Kosambi, noted mathematician, has already joined the staff. It is likely that Prof. Pauli, Nobel Laureate, will spend some time in the Institute as a visiting professor.

It would be recalled that the Governing Body of the Council of Scientific and Industrial Research at its meeting held in September 1945, made a grant of Rs. 75,000 to the Institute.

India and German Reparations

In the allocation of shares in German reparations to the participating countries, the Paris Reparations Conference, which was held from 9th November to 21st December 1945, in terms of the Potsdam Declaration, recommended that India should be accorded 2 per cent. of the total reparations which gives her the tenth place among the 18 participants, and 2.9 per cent. in respect of capital goods which gives her the ninth place in that category. Capital goods include industrial and other capital equipment removed from Germany and ships, while all other forms of German reparation such as foreign assets, current production and stock, etc., are included in the first category.

As the allocation of shipping is based on the tonnage of shipping lost through enemy action during the war, India has little chance of getting German ships as part of her reparations which will be confined to industrial and other capital equipment. German assets in India will be available towards adjustment of a part of the dues, the remaining part being made up of claimable German assets released by neutral countries and share of German current production and stocks as and when they become available and declared surplus to that country's internal economy.

Overseas Training of Indian Students

354 candidates were selected for the Central and 236 for the Provincial Government Scholarships in 1945 for higher technical education overseas, says the Report of the Selection Board, Overseas Scholarships, recently published by the Government of India.

These scholarships are at present confined to Universities and Technical Institutions in the U.K., U.S.A. and Canada. It is, however, hoped that some places may be made available in Australia and New Zealand, and negotiations with that end in view are already in progress.

Future Selection

The Report draws attention to the need for an agreement with the Provincial Governments as to the general lines of selection in order that greater uniformity of standards may be secured. There was this year a marked difference between the standards of the Central Selection Board and those of some of the Provinces. The Report also says that the varying records of many candidates who passed from one university to another strengthens the impression that there are differences of standard between one university and another. The Board have recommended that the results of selection for these scholarships should be carefully analysed so as to help universities in equating their standards.

It is announced that 600 Overseas Scholarships will be granted by the Central and Provincial Governments to Indian students for studies abroad during the year 1946-47.

Travancore Fertilizers and Chemicals, Ltd.

The Administration Block of buildings of the Fertilizers and Chemicals, Ltd., was declared open by H.H. the Eliya Raja, on 1st December 1945. In his speech, *Sachivottama* Sir C. P. Ramaswamy Aiyar, stated that the policy of His Highness' Government was to make the agriculture of Travancore apt and sufficient to the needs of the people. Government

proposed to reclaim more land from back waters, and by the application of scientific knowledge and fertilizers to make the land yield more. The programme of industrialization pursued by the State is based upon the natural facilities and resources of Travancore. The Dewan expressed the hope that the new industry will be an effective factor not only in the rapid agricultural growth and industrialization of the country, but will also place Travancore not on the Indian map alone but on the map of the world as an active unit of well organized industrial development.

Announcements

New Year's Honours for British Scientists. The New Year's Honours list includes, among others, the following men of science well known in this country:

G.B.E.: Sir Edward Appleton, Secretary, Department of Scientific and Industrial Research, London.

Companion of Honour: Prof. A. V. Hill, Secretary, Royal Society for Scientific Services.

Knights: Dr. E. J. Salisbury, Director of the Royal Botanic Gardens, Kew; Mr. W. Akers, Director of Atomic Bomb Research, Department of Scientific and Industrial Research; Prof. I. M. Heilbron, Professor of Organic Chemistry in the Imperial College of Science and Technology, London.

Empire Scientists' Conference. A team of 14 Indian scientists is expected to attend the Empire Scientific Conference to be held in London next summer. The conference is being sponsored by the *Royal Society* to discuss the setting up of an organization to co-ordinate scientific research in the British Commonwealth.

The Government of India have selected seven officials and seven non-officials to represent India. The members are: Sir C. V. Raman, Sir J. C. Ghosh, Dr. Meghnad Saha, Prof. Birbal Sahni, Dr. M. R. Siddiqui, Dr. Jamshed Bhabha, Prof. Mahalanobis, Khan Bahadur Afzal Hoosain, Sir S. S. Bhatnagar, Col. S. S. Sokhey, Dr. D. N. Wadia, Dr. S. L. Hora, Dr. M. S. Krishnan and Dr. J. N. Mukherji.

The two-month programme suggested by the *Royal Society* will include visits to centres of scientific research in England such as Oxford and Cambridge.

Dr. W. D. West has been appointed Director, Geological Survey of India.

Dr. L. A. N. Iyer has been appointed J. N. Tata Professor of Geography, Patna University.

Prof. Mata Prasad has been appointed Principal, Royal Institute of Science, Bombay.

Atomic Energy Commission. The General Assembly of the United Nations Organization, unanimously decided, on 24th January, to set up an Atomic Energy Commission to internationalise secrets of the atom. The Commission will have the multiple task of preventing the destructive use of the atomic bomb and of facilitating the international exchange of scientific information to foster peaceful applications of the discovery.

Index of Industrial Raw Materials. The Economic Adviser's All-India Index of wholesale prices of industrial raw materials worked out to 266 for the week ended 5th January, 1946, as compared with 260 for the previous week.

During the week, the indices for 'minerals' and 'miscellaneous' remained stationary, while those for 'fibres' and 'oilseeds' rose by 7 and 6 points respectively.

INDIAN PATENTS

[The following is a list of Patent Applications noted as accepted in the *Gazette of India*, Part II—Section 1, for November-December 1945.]

31978. MANUFACTURE OF NITRO COMPOUNDS: *Causing a Δ -nitroolefine to interact with organometal halide.*—I.C.I., Ltd.
32026. 2-AMINO-4:6-DIMETHOXYPYRIMIDINE: *An intermediate for the manufacture of pharmaceuticals, by action of pyrimidine derivatives on sodium methoxide in presence of an inert high boiling solvent.*—I.C.I., Ltd.
32230. OXIDATION PRODUCTS OF POLYMERS AND INTERPOLYMERS OF ETHYLENE: *The high molecular weight polymers from ethylene are oxidised with air or other oxidising agents at elevated temperatures with the formation of carboxylic acids.*—I.C.I., Ltd.
32240. HEAT EXCHANGE DEVICE: *Comprising a plurality of tubular elements threaded through apertures in and bonded to transverse fins and plurality of corrugated elements placed in passages between tubular elements and the fins.*—I.C.I., Ltd.
32371. CONNECTING MEANS FOR STRUCTURAL COMPONENTS: *A pair of interlocking members, one provided with slot-forming channels which receive the marginal portions of the other.*—Kari.
32376. PRESERVATION OF TEXTILE MATERIALS OR PAPER: *By applying zinc dimethyldithiocarbamate in aqueous ammonia.*—I.C.I., Ltd.
32415. PISTON: *Provided in its skirt with a nonsplit ring of material having a co-efficient of expansion less than that of the piston skirt but comparable to that of the cylinder, so as to control the expansion of the skirt.*—Wellworthy Piston Rings Ltd. and Howlett.
32512. FUMIGATION: *A process for making a fumigating agent, thiophosgene by a reaction between hot chloroform vapour and sulphur dioxide, and an apparatus for using the same.*—Barton and Chapman.
32564. VALVE GUIDES FOR FLUID-COMBUSTION ENGINES: *Moulded from iron powder made by electro deposition or reduction from iron oxides and heated to about 1100° C.*—Bound Brook Bearings (G.B.) Ltd.
32565. VALVE GUIDES FOR FLUID-COMBUSTION ENGINES: *Moulded from powdered mixture of alloy of iron and copper in the proportion 85 per cent. to 95 per cent. and 15 per cent. to 5 per cent. respectively and heated 1100° C.*—Bound Brooke Bearings (G.B.) Ltd.
32566. VALVE GUIDES FOR FLUID-COMBUSTION ENGINES: *Moulding under pressure powdered mixture or alloy of copper and tin contained in proportions 88 per cent. to 90 per cent. and 12 per cent. to 10 per cent. respectively heated to about 800° C.*—Bound Brooke Bearings (G.B.) Ltd.
32597. ROLLER-WEIGHING MEANS FOR TEXTILE DRAWING, SPINNING AND ANALOGOUS MACHINERY: *A saddle, a depending link, means for tensioning the link, and means to transfer the tension to the saddle.*—Howard and Bullough Ltd. and Hunter.
32627. DEVICE FOR GUIDING SHUTTLES ON CIRCULAR WEAVING LOOMS: *Sliding track having a U-shaped profile, open towards the centre of the loom, apertured at bottom for passage of warps.*—Societe Dite: Saint Freres (Societe Anonyme).
32628. MOVING PICTURES: *Forming real image of background and moving object on a small size model and focussing on camera.*—Dufour.
32702. DEVICE FOR GUIDING THE SHUTTLES IN CIRCULAR WEAVING LOOMS: *Shoes of shuttles slide between two series of needles.*—Saint Freres Societe Anonyme.
32730. RENDERING TEXTILE FABRICS RESISTANT TO SHRINKING AND CREASING: *Impregnating textile material with an aqueous solution of monomeric methylol melamine condensation product.*—Monsanto Chemical Co.
32806. APPARATUS FOR THE DETERMINATION OF THE FLUIDITY OF MOLTEN METALS: *Comprising a mold having a reservoir, a pouring basin, a strainer core and a spiral runway with plurality of outlets.*—International Meehanite Metal Co., Ltd.
32829. VOLTAGE LIMITING DEVICE: *Impedance connected in series to a unidirectional conductor so biased that a voltage exceeding a determined value causes a current flow causing a drop in input voltage.*—B. P. L. (Instruments) Ltd.
32831. GUIDING, FILLING AND COMPACTING SLIVER OR THE LIKE INTO SLIVER CANS: *Adjusting the delivery rollers for compacting sliver and providing a bell mouth for preventing lateral escape of sliver.*—Nicoll.
32857. ALLOY FOR USE IN ELECTROLYTIC CELL: *An alloy of lead, bismuth and mercury.*—Forsgren and Forsgren.
32878. ELEVATING MECHANISM FOR LOADING SHOVELS OR THE LIKE: *Pull of winch and cable mechanism transmitted to the jib through a strut which folds and unfolds as the jib is lowered or raised.*—Boydell and Co., Ltd., Coldwell and Benyon.
30358. PRESS TOOLS FOR BENDING TUBES OR RODS: *A slidable member engaging the tube or rod in timed relation with the movable part of the tool increases the curvature of a bend.*—Blackburn Aircraft Ltd.
30359. PRESS TOOLS FOR BENDING TUBES OR RODS: *Form block, at least two guideways at an angle, slidable thrust members in guideways and at least two cams.*—Blackburn Aircraft Ltd.
31248. MANUFACTURE OF INDUSTRIAL AND POWER GASES: *Generator provided with automatically operated grate or liquid ash bed.*—Steinschlaeger.
31505. AUTOMATIC CONTROL OF THE MELTING OF COATING ON CONTINUOUS METALLIC STRIPS: *Varying voltage of resistance heating according to speed of strip.*—Carnegie-Illinois Steel Corp.
31518. CURRENT REGULATING SYSTEMS: *Bus bar connected to D. C. and two coupled windings connected to A. C.*—Carnegie-Illinois Steel Corp.

31537. FLAME-MACHINING OR FLAME-CUTTING METAL BODIES: *Adjuvant material introduced into the oxidizing gas stream and discharging the inform mixture from the nozzle against a heated portion of the metal body.*—The Linde Air Products Co.
31626. PERFORATION OF SHEET MATERIAL BY ELECTRICAL DISCHARGES: *Substance having a lower electrical resistance than material to be perforated disposed in the path of the electrical discharges.*—DePenning.
31673. TRACTOR AND PUSH GRADER COMBINATION: *Combination of a tractor and a support between a pair of the wheels, a push grader with vertically adjustable grader blades and a pair of push beams.*—Le Tourneau, Inc.
31744. MECHANICAL HAMMERS AND OTHER PERCUSSION TOOLS: *Flywheel rigid with eccentric shaft and a torsionally resilient coupling connected between said shaft and a driving motor.*—Feuerheerd.
31778. AN IMPROVED AMPOULE: *One chamber closed by a resilient closure the other chamber having a neck received in the closure to form a valve seal to open by manipulation.*—Bayer Products Ltd., Watson and Hackett.
31900. APPARATUS FOR COOLING OR ATTEMPERATING OIL: *Uniform distribution of oil throughout matrix plurality of baffle perforates impeding flow of oilpath in shorter paths.*—I.C.I., Ltd.
32084. STEAM GENERATORS: *A vertical steam generator provided with a vertical fire-box, a continuous sheathing round the fire-box interstitial space between them filled with circulating water, inlet and outlet for water provided therewith.*—Minimax Ltd.
32131. LOCKS: *Locking bolt having two alternative locking positions.*—Holan.
32290. LATCH DEVICES: *Latch having rotatable cam plate and key-operated locking means.*—Young.
32951. SOCKET MEMBERS OF ELECTRICAL PLUG AND SOCKET CONNECTIONS: *Includes a safety device in the form of a switch closing or opening the circuit when the plug is in the socket.*—Dorman & Smith Ltd., Atherton and Ryder.
33004. SEPARATION, RECOVERY OR REFINING OF METALS: *Selective oxidation or complete oxidation followed by selective reduction by use of suitable atmosphere.*—Robiette and Hancock.
31443. NITROETHYLENE: *Reacting dinitroethane and/or B-nitroethyl nitrate with alcohol.*—I. C. I. Ltd.
31783. DETERMINING THE TENSILE STRESSES IN HAULAGE AND OTHER ROPES: *Variation of bending moments produced in a bar having the rope passing over pulleys suitably suspended from ends.*—British Ropes Ltd.
32042. TIME-OPERATED ELECTRIC SWITCHES: *Comprising a magnet and an armature which loses its magnetic properties when heated.*—Hindle.
32121. STRAPPING MACHINES: *Strapping machine for securing the overlapping ends of bands used for strapping bales.*—Mosey.
32256. PARTY LINE RINGING ARRANGEMENTS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS: *Using electron discharge tubes in a system of party line and arranging that a direct current potential characteristic of each party line station operating a register controller for applying a selected source of ringing current to the called party line.*—Standard Telephones and Cables Ltd.
32259. ELECTRICAL SIGNALLING SYSTEMS: *Signalling performed by unidirectional current impulses operating polarised or unpolarised relay controlling the selector at the exchanges.*—Standard Telephones and Cables Ltd.
32288. TOOL HOLDER FOR A LATHE OR THE LIKE: *Tool holder in which a clamping block is used for wedging the tool into a corner so that it is held by frictional engagement with at least two faces of the tool.*—Clark.
32750. AXLE BOXES: *Outer frame is attached to tubular band by longitudinally extending gusset plates disposed in longitudinal planes above and below the axis of the axle box and welded to the barrel and the outer frame.*—British Timken Ltd.
32884. SELF-CENTERING BEARING FOR WHEELS: *Bearing surfaces of the journal and the hub formed with curved surfaces of different radii.*—Morgan.
32894. QUICK RELEASE PARACHUTE HARNESS: *Connector or connectors and attaching member carried by harness elements are releasably retained by a retaining member.*—Pioneer Parachute Co., Inc.
32913. PHOTOGRAPHIC APPARATUS: *Endless chain carrying film supporting rods, dips the film in treating tanks for predetermined time, being actuated electrically.*—Daly.
29738. LUBRICATING OIL: *Having dispersed therein an aromatic polysulphide.*—C. C. Wakefield & Co., Ltd.
30622. ORGANIC NITROGEN COMPOUNDS. 1:2 Dinitroethane is prepared by reacting nitrogen tetroxide with ethylene at low temperature.—I. C. I. Ltd.
30649. MOTOR SPIRIT AND LUBRICANTS: *Heating oil-bearing vegetable seed and passing vapours direct to an oil cracking plant.*—Worsley.
31027. RECOVERY OF BUTYLENE GLYCOL FROM CARBOHYDRATE FERMENTATION MASHES: *The cream obtained by adding alkaline earth material to a liquid concentrate of a carbohydrate fermentation is treated with alcohol.*—I. C. I. Ltd.
31495. AMIDATION OF ESTERS: *Reacting an ester with ammonia or an amine in presence of an alkali metal alcoholoxide.*—Lankro Chemicals Ltd.
31533. INHIBITING AND DESTROYING PATHOGENIC MICRO-ORGANISMS: *Containing monocarboxylic fatty acids containing three to eleven carbon atoms.*—Ward Baking Co.
31550. POCKET KNIVES: *Tang of the blade is pivoted about an axis, transverse to the longitudinal plane thereof, between scales and is also pivoted about a second axis contained in that medium plane and at right angles to the first.*—Fairst.
31731. SUBSTITUTED QUINOLINES AND THEIR INTERMEDIATES: *Condensing a haloamine with an aminoquinoline derivative.*—Eli Lilly & Co.
31748. COMPOUNDED LUBRICATING OIL: *Lubricating oil containing an oil-miscible metal salt of an organic compound and an amine and a sulphur containing antioxidant.*—Shell Development Co.
31793. NEW ANTIMALARIALS: *Condensing an aminoquinoline derivative with a reactant of the formula $Ha-CH_2-CH_2-N-RR_1$.*—Eli Lilly & Co.
31863. REINFORCED RUBBER ARTICLES: *Applying to a fibrous reinforcement structure a cyanate.*—E. I. Du Pont de Nemours and Co.
32119. ARTIFICIAL THREADS, FILAMENTS AND THE LIKE: *Solidifying filament from polythene and applying tension.*—I.C.I. Ltd.

SOAP GELS IN NON-AQUEOUS MEDIA

By G. S. HATTIANGDI

(Chemical Laboratories, Royal Institute of Science, Bombay)

SYSTEMATIC work on soap gels in non-aqueous media is almost lacking, in spite of the fact that ionic and Donnan equilibria are eliminated in these systems and the results gain significance from the simplicity of the conditions. The earliest work on these gels in alcoholic media seems to have been done by Fischer and co-workers¹ and Laing and McBain². The latter find that sodium and potassium soaps of the fatty acids crystallize out of anhydrous alcohol in the form of flakes, and jellies are formed on cooling only when sufficient amount of water is present in the system to bring the colloid into solution. Soap gels have also been prepared in non-aqueous media of the hydrocarbon type. The earliest work is due to von Weimarn³ who prepared gels of sodium oleate in a number of solvents and described in detail the conditions under which these gels were most stable. McBain and McClatchie⁴ examined the behaviour of a number of soaps in xylene and found some of the gels to be isotropic when seen through crossed nicols. A study of soap gels in nujol has been made by Lawrence⁵ who also gives references to the scattered work on metal-soap systems in non-aqueous media. Prasad and co-workers^{6,7} have prepared transparent, heat-reversible gels of various sodium and potassium soaps in pinene and have systematically studied their several properties.

The present investigation is devoted to the preparation and study of the behaviour of some soap gels in several non-aqueous media in order to see how far the properties of the gel change with the nature of the solvent in which a soap is dissolved. For this purpose, the time of setting of the soap systems has been measured, as this property is considered by several workers to be characteristic of a gel-forming system. The effects of the soap content as well as of temperature on the time of setting have also been studied. The gels investigated are those of sodium oleate and sodium stearate in toluene, xylene, pinene and nujol.

Experimental

The sodium oleate and sodium stearate

used in this investigation were products of Messrs. E. Merck, and the toluene, xylene, pinene and nujol were obtained from Messrs. E. Merck, Riedel-Haen, Eastman Kodak, and Stanco Inc., respectively.

Sodium oleate and sodium stearate are insoluble in all the solvents at 30° C. However, both the soaps swell on heating with xylene, pinene and nujol; as the temperature is slowly increased, the soaps suddenly dissolve into clear mobile solutions which set to transparent, elastic gels on cooling below the "dispersion temperature." Sodium oleate behaves similarly with toluene, but sodium stearate shows no signs of gelation in toluene. The soaps dissolve in toluene, xylene, pinene and nujol in the neighbourhood of 90° C., 120° C., 140° C. and 250° C. respectively.

The time of setting of the several gel-forming systems containing different amounts of either soap dissolved in 10 cc. of the different solvents was measured by Fleming's method⁸, and the experimental technique was the same as that adopted in previous investigations⁷. It may be pointed out that the time of setting at a temperature has been taken as the time taken by a gel-forming solution to set when cooled from the temperature at which it is prepared to the temperature of observation. This time should not be confused with the time taken by the gel-forming system to attain the temperature of the thermostat when it is cooled from the high temperature at which the solution is prepared. The significance of this remark will be understood from the fact that in the case of these inorgano-organic gels in non-aqueous media, the two processes of cooling and gel-formation take place simultaneously. Prasad, Hattiangdi and Vishvanath⁷ have examined this aspect critically and find that in the case of the quick-setting gels, the setting takes place much before the gel-forming system attains the temperature of the bath. They have hence concluded that no stage of the process of setting is completed at the temperature to which the gel-forming solutions are cooled. The results of the measurements of the time of setting of gels of sodium oleate

and sodium stearate in toluene, xylene and nujol are given in Tables I and II; the data of the time of setting of the gels of both the soaps in pinene are recently published by Prasad, Hattiangdi and Vishvanath⁷.

TABLE I. *Sodium Oleate Gels in Non-aqueous Media.*

Soap content "A" gms.	Time of setting			
	t_{35°	t_{45°	t_{50°	t_{60°
TOLUENE				
0.08	0' 50"	1' 10"	1' 27"	2' 3"
0.09	0' 40"	0' 55"	1' 8"	1' 25"
0.10	0' 35"	0' 43"	0' 52"	1' 10"
0.15	0' 20"	0' 29"	0' 35"	0' 44"
0.20	0' 12"	0' 17"	0' 21"	0' 30"
0.25	0' 9"	0' 12"	0' 15"	0' 20"
XYLENE				
0.08	2' 35"	3' 36"	4' 30"	5' 20"
0.09	2' 0"	2' 49"	3' 20"	4' 22"
0.10	1' 30"	2' 0"	2' 30"	3' 23"
0.15	0' 59"	1' 15"	1' 30"	2' 12"
0.20	0' 29"	0' 45"	0' 57"	1' 25"
0.25	0' 12"	0' 18"	0' 25"	0' 42"
NUJOL				
0.08	1' 25"	1' 40"	1' 50"	2' 12"
0.09	1' 10"	1' 24"	1' 33"	1' 52"
0.10	0' 55"	1' 6"	1' 15"	1' 30"
0.15	0' 30"	0' 43"	0' 52"	1' 12"
0.20	0' 20"	0' 30"	0' 36"	0' 52"
0.25	0' 13"	0' 19"	0' 24"	0' 35"

TABLE II. *Sodium Stearate Gels in Non-aqueous Media*

Soap content "A" gms.	Time of setting			
	t_{35°	t_{45°	t_{50°	t_{60°
XYLENE				
0.08	2' 45"	4' 5"	4' 55"	7' 5"
0.09	2' 10"	3' 0"	3' 42"	5' 18"
0.10	1' 45"	2' 28"	2' 58"	4' 10"
0.15	1' 13"	1' 38"	1' 58"	2' 40"
0.20	0' 45"	1' 0"	1' 15"	1' 35"
0.25	0' 13"	0' 21"	0' 32"	0' 48"
NUJOL				
0.08	1' 27"	1' 48"	2' 2"	2' 29"
0.09	1' 14"	1' 33"	1' 42"	2' 3"
0.10	1' 8"	1' 19"	1' 27"	1' 45"
0.15	0' 50"	1' 1"	1' 6"	1' 19"
0.20	0' 44"	0' 52"	1' 2"	1' 12"
0.25	0' 32"	0' 42"	0' 51"	0' 57"

Discussion of Results

The time of setting of gels of sodium oleate and sodium stearate in either of the media used decreases as (i) the amount of the soap in the system is increased, and (ii) the temperature to which the gel-forming mixture is allowed to cool is lowered. The manner in which the time of setting of gels containing the same amount of soap and cooled to the same temperature is affected by a change in the dispersion medium, is

well brought out by the curves in Fig. 1; these curves are the plots of the time of setting against the soap content of the system, and relate to gels of sodium oleate in the different media at 50° C. It will be seen from these curves that the gels in toluene and nujol invariably set faster than those in xylene and pinene, the gels in toluene being the quickest to set.

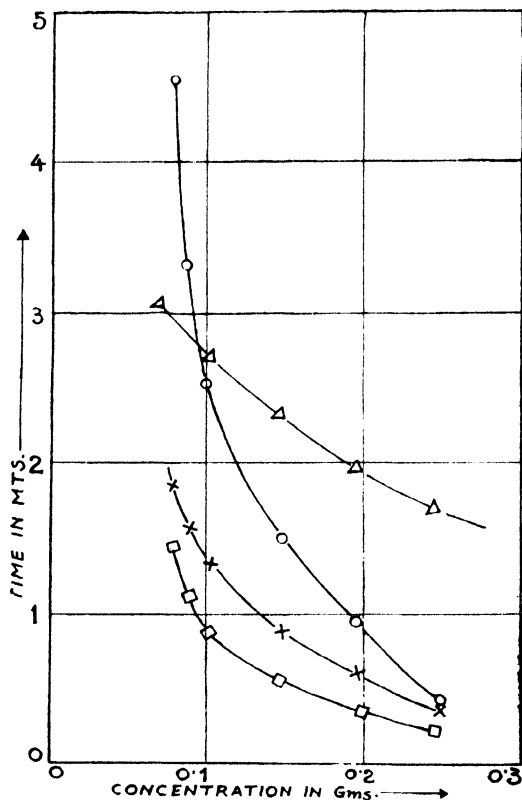


Fig. 1.

Δ =pinene, \circ =xylene, \times =nujol, \square =toluene.

Prasad and co-workers⁷ have shown that Hurd and Letteron's extension¹⁰ of Arrhenius's equation is applicable to the case of soap gels in pinene. An attempt was made to see if the equation is applicable to soap systems in other non-aqueous media also. On plotting the values of $\log t$ (t is the time of setting) against $1/T$ (T is the absolute temperature to which the gelating solution is allowed to cool), sets of parallel straight lines were obtained for each soap system in the various solvents, showing that Arrhenius's

equation is applicable to these systems as well. Following the procedure adopted by Hurd and Letteron, the values of the Heats of Activation, Q , for the setting process in the case of the several soap-solvent systems were obtained by multiplying the values of the slopes of the various curves for $\log t$ against $1/T$ by $2.303R$. Since the values of Q are found to be almost independent of the soap contents of the gels within the range studied, their mean values for the different soap-solvent systems are given in the following table.

TABLE III

Heat of activation Q (calories)

Solvent	Heat of activation Q (calories)	
	Sodium oleate	Sodium stearate
Toluene	—6776	—
Xylene	—6713	—7775
Pinene	—3202	—2820
Nujol	—5741	—4324

The various important stages taking place during the sol-gel transformation of a soap system in pinene have been pictured by Prasad and co-workers⁷ to take place as follows: True solution \rightarrow colloidal solution \rightarrow true gel. The same mechanism is involved in the gelation of soap systems in the non-aqueous media dealt with in this investigation. A solution of a soap in either of the solvents is a true solution at its boiling point. As stated earlier, both these soaps are insoluble in these media at low temperatures. Hence, when a solution of a soap in either of these non-aqueous media is cooled gradually, saturation of the system is caused by the reduction in solubility of the solute. From this stage onwards, the saturated solution of the soap and not the pure solvent acts as the dispersion medium, and the soap micelles remain suspended in the system. It has been observed that further cooling could produce either (i) crystallization of the solute from the solution, or (ii) the formation of a pseudo-gel, consisting of a suspension of micro-crystals of the solute in the dispersion medium, or (iii) the formation of a true gel. Since a true gel is formed in all the cases dealt with in this paper, it would appear that the very large molecules whose shape is too irregular to form a regular crystal lattice form a three-dimensional meshwork linked together at random points of adhesion. The size of the resulting micelle is fixed by "packing" considerations; thus at first the size would remain constant as the temperature falls but their number would

increase, and further cooling would result in an increase in the size (solvation) and not in the number of the particles. These large molecules which are also insoluble in the dispersion medium approach one another in virtue of their kinetic motion, and as the system gradually thickens due to the increase in the size of the micelles, a restriction is imposed on the degree of freedom of the individual micelles which leads to the reduction in their kinetic energy which is released in the form of heat at the point when the system goes over from the sol to the gel state, a stage when the system reaches its maximum of activity. However, the structural changes continue to take place in the gel system even after the setting point has been reached; this is manifested by the development of the opacity, the modification of the mechanical properties, and in some systems by syneresis, when the gel is allowed to stand for some time. Thus though we have some idea regarding the stages involved in the gel formation of the soap systems in non-aqueous media, yet we have no sufficient knowledge regarding the stability of the systems, a subject which has not received the attention it deserves.

The behaviour of the two soaps in different non-aqueous media before and after setting, makes an interesting study. Sodium oleate and sodium stearate swell and dissolve in xylene when heated to about 120° C.; on cooling, elastic gels are obtained which undergo profuse syneresis. The gel reforms on heating and it appears to be in the most stable state between 80°-90° C. Sodium oleate behaves similarly in toluene, but the extent of syneresis is less. The gels of sodium oleate in pinene synerise when allowed to stand for some time after the setting point has been reached, but those of sodium stearate in pinene are quite stable at most temperatures between 30° and 90° C., and do not synerise at all. Both these soaps swell on heating with nujol and dissolve suddenly at about 250° C. and the resulting solutions set to clear, transparent, elastic gels on cooling. On standing, however, slight opacity develops but neither of the gels show the phenomenon of syneresis to any marked degree.

It will be seen from the above observations that a soap gives rise to a syneretic gel in one medium and a non-syneretic one in another. It was, therefore, considered interesting to examine the effect of the addition

of different amounts of several soaps and dispersion media to a syneretic soap gel system. For this purpose, the gels of sodium oleate in pinene were chosen because the kinetics of the syneresis of these gels has been systematically studied by Prasad, Hattiangdi and Mathur⁹ who observe that the addition of certain substances to these gel-forming systems either accelerates or retards the velocity of syneresis. The amount of synereticum exuded in the presence of the addition agents at a given temperature (30° C.) and at a fixed interval of time from a gel system containing 0.09 gm. sodium oleate in 10 cc. of pinene was determined by the method adopted by the previous workers. The results obtained are given in Tables IV and V as percentage retardation or acceleration, the exudation of liquid by the gel without any added substance is taken as 100.

TABLE IV.
Time=1 hour

Soap added gms.	Percentage retardation		
	Sod. stearate	Sod. palmitate	Pot. palmitate
0.005	—	62.1	—
0.007	—	70.9	—
0.010	27.9	78.7	70.1
0.015	—	90.0	—
0.020	51.0	—	79.0
0.030	62.7	—	—
0.040	—	—	86.2
0.050	87.5	—	89.1

TABLE V.
Time=2 hours

Non-aqueous media added cc.	% acceleration (+) or retardation (-)			
	Xylene +	Toluene -	Benzene -	Nujol -
0.4	—	11.5	—	—
0.5	14.2	—	20.8	—
0.6	—	16.1	—	—
0.8	—	12.9	—	—
1.0	10.8	9.4	25.9	45.7
2.0	6.1	9.3	22.4	82.2
2.5	—	—	—	89.0
2.7	—	—	—	91.5
3.0	5.8	9.4	22.4	94.4
4.0	—	—	—	97.6

It will be seen from Table IV that on adding small increasing quantities of soaps to the syneretic system of sodium oleate in pinene, all the soaps retard and finally tend to stop the syneretic phenomenon, the retarding effect being in the order sodium palmitate > potassium stearate > sodium stearate. The results given in Table V show that three of the four non-aqueous solvents

studied have a retarding effect, whereas the other, namely xylene, actually accelerates the velocity of syneresis. The retarding effect is in the order nujol > benzene > toluene; benzene and toluene cannot stop syneresis completely even when sufficiently large amounts of either of these substances are present in the synerising system, but the gel exudes no liquid when a sufficiently small amount of nujol is present in it, and in this respect the behaviour of nujol is comparable to that of the added soaps.

The results mentioned above may have an important bearing in technical and industrial problems inasmuch as the syneretic process can be controlled very easily, and hence the need for a systematic study of the stability of these and other gels is strongly emphasized.

The author feels grateful to Prof. Mata Prasad, D.Sc., F.R.I.C., for his kind advice and criticism, to the authorities of the University of Bombay for the award of a University Research Scholarship, and to Mr. S.P. Adarkar, M.Sc., for collecting some experimental data incorporated in this paper.

Summary

The behaviour of sodium oleate and sodium stearate towards several non-aqueous media before, during and after the process of gel formation has been critically examined. The time of setting of the gels of these two soaps in the different media has been measured and their Heats of Activation have been calculated. Addition of other soaps and non-aqueous media have a profound influence on the phenomenon of syneresis of some of these gels, which is one of the criteria for determining their stability.

References

- 1 Fischer and co-workers, *Koll. chem. Beih.*, 1922, 15, 3.
- 2 Laing and McBain, *Koll. Z.*, 1924, 35, 19.
- 3 Von Weimarn, *Die Allgemeinheit des Kolloidzustandes*, 1925, Bd 1, Aufl 2, pp. 352-363; *J. Russ. Phys. Chem. Soc.*, 1914, 46, 610, 624; 1915, 47, 2163; 1916, 48, 532.
- 4 McBain and McClatchie, *J. Phys. Chem.*, 1932, 36, 2567.
- 5 Lawrence, *Trans. Farad. Soc.*, 1938, 34, 660.
- 6 Prasad and Hattiangdi, *Proc. Ind. Acad. Sci.*, 1945, 21, 1.
- 7 Prasad, Hattiangdi and Vishvanath, *Proc. Ind. Acad. Sci.*, 1945, 21, 56.
- 8 Flemming, *Zeit. Phys.*, 1902, 41, 427.
- 9 Prasad, Hattiangdi and Mathur, *Proc. Ind. Acad. Sci.*, 1945, 21, 105.
- 10 Hurd and Letteron, *J. Phys. Chem.*, 1932, 36, 606.

THE USE OF DDT AND 666 AS INSECTICIDES AGAINST GRAIN PESTS

PART III—THE PERSISTENCE OF TOXICITY OF DDT AND 666 APPLIED IN WALL WASHES

(From the Ordnance Laboratories, Cawnpore)

THIS paper embodies the results of experiments carried out with the object of determining the degree of persistence of the insecticidal effect of *DDT* and *666* in lime and chalk washes, at periods up to four months from the date of treatment. Further entomological data are presented to confirm the fact that *DDT* is destroyed by lime.

Experimental

Boxes.—The experimental chambers were prepared from cement concrete and had internal dimensions of $5\frac{1}{2}$ " x $5\frac{1}{2}$ " x 4", with walls about $1\frac{1}{2}$ " in thickness. The tops were open and glass plates were cut to serve as covers, being held in place by putty.

Test Insects.—In these experiments only *Tribolium castaneum* has been used. The insects were obtained from a large natural population infesting a local grain store.

Insecticides.—*DDT*—Crude product having a pp' isomer content of 85 per cent. *666*—Crude product containing 10-12 per cent. of benzenehexachloride.

Emulsions and Washes.—The details have been reported in Part I of this series¹.

Experiments :—

1. A further test on the boxes treated with *DDT* emulsion in lime wash—Serial Nos. 7, 8 and 9 of Series II, Part I. This test commenced one month after the date of the initial treatment of the boxes. Results are shown in Table I.
2. A further test on the boxes treated with *DDT* mechanically mixed in lime wash, Series I of Part I, after a lapse of over 4 months from the date of treatment. Results are shown in Table II.
3. A series of three boxes was treated with *DDT* emulsion in lime wash as in Series II of Part I. These boxes were then allowed to stand for three days before the admission of the insects. The results of this experiment are shown in Table III.

4. A comparison of the insecticidal effects of old treatments, using *DDT* and *666* emulsions in chalk wash, with identical fresh treatments. Results are shown in Table IV.

Results.—The results are given in Tables I—IV and graphically represented in Fig. 1.

Discussion

It has already been shown² that *DDT* in alcoholic solution or in oil-in-water emulsion is rapidly decomposed in lime wash with production of the dichloro-olefine. The results in Tables I and II provide entomological confirmation of the extent of this destruction. Emulsion in lime wash treatments, tested after a period of one month from treatment do not show any higher mortality than that of the control, indicating complete destruction of the *DDT*. *DDT* lime wash mixture treatments, however, tested four months after treatment, still produce 30-40 per cent. mortality in eighteen days in the case of the two highest concentrations used. These results are in agreement with the chemical findings, which showed no evidence of *DDT* destruction in mechanical mixtures of *DDT* and lime suspended in water.

The concentrations of *DDT* in the emulsion and mixture treatments are comparable in the ratio of insecticide to inert base, although much more wash has been applied to each box in the case of the mixture treatments. It is considered that the ratio of insecticide to inert base is the figure most directly related to the insecticidal effect, since the effect of the increased quantity of insecticide applied in heavier washes is largely negated by the occlusion of the insecticide present in the lower layers of the deposit. The degree to which a wash is bound together may also be a factor of some importance, since a thick loosely bound wash may deposit as dust on insect bodies, producing a greater insecticidal effect.

The rapidity of the effect of lime on *DDT* in the emulsion treatments is illustrated by the results in Table III. In this series of experiments, the boxes were allowed to

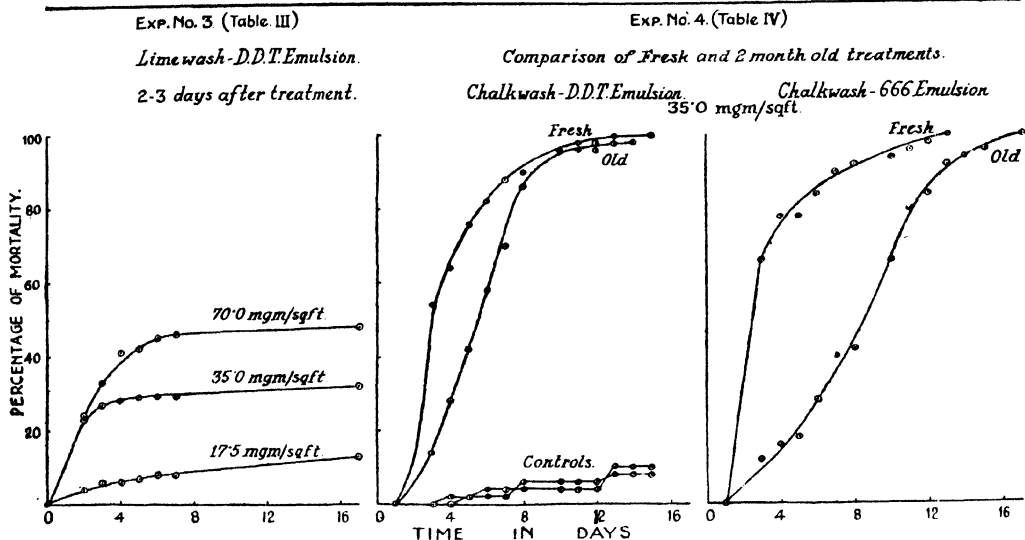


Fig. 1.

stand for 2-3 days after treatment before the admission of the insects. The insecticidal effects produced are much lower than those for corresponding treatments in which tests were started on the day after treatment (See Part I, Table III).

Table IV and the associated graphs show the results of experiments in which the insecticidal activities of two months old DDT and 666 emulsion deposits (35.5 mgm/sq.ft.) in chalk wash are compared with corresponding fresh treatments. It is evident that the degree of persistence of both DDT and 666 emulsions in chalk wash is good. In the case of DDT, the time to produce 70 per cent. mortality is increased from 4½ to 7 days and with 666 the corresponding increase is from 4-10 days. In all cases

100 per cent. kills are produced in from 12-18 days.

Conclusions

1. DDT in an oil-in-water emulsion with lime wash is rendered completely inactive. The deposit becomes ineffective within a few days of application.
2. The degree of persistence of the insecticidal effects of DDT and 666, applied as oil-in-water emulsion treatments with chalk wash, is good. Useful insecticidal effects persist two months after treatment.

References

1. *J. Sci. Ind. Res.*, 1945, 4, 73.
2. *Ibid.*, 1945, 4, 78.

THE USE OF DDT AND 666 AS INSECTICIDES AGAINST GRAIN PESTS

PART IV.—DDT AND 666 AS STERILISANTS OF FLOOR DEBRIS IN GRAIN STORAGE SHEDS

(From the Ordnance Laboratories, Cawnpore)

Introduction

THIS paper is the result of three series of experiments, extending over a period of three months, carried out in order to compare the insecticidal efficiency of DDT

with that of 666 when used in the form of a dust to effect the sterilization of floor debris. The standard of cleanliness of grain storage places in India is often far from satisfactory, and in many cases, the loose type of construc-

tion of the building and floors renders the complete removal of accumulated grain debris impracticable. It was with a view to the use of *DDT* and *666* in the sterilization of such material that this investigation was carried out.

In the experiments carried out in these laboratories, the insecticide was dispersed in kaolin and mixed in various concentrations in *atta* (whole wheat flour) infested with *Tribolium castaneum*.

Experimental

Insecticides—

- (a) *DDT*—pp¹ isomer content 80 per cent. estimated chemically.
- (b) *666*—Crude plant product with an active isomer (γ Benzenehexachloride) content of 10-12 per cent.
- (c) *666*—16 per cent. dust of *666* and gypsum.
- (d) *666*—4 per cent. dust of *666*. (c) diluted with four parts china-clay.

The *666* samples were supplied by Messrs. Imperial Chemical Industries Ltd., who provided the information with regard to the γ -isomer content.

Grain Debris.—With a view to reducing to a minimum variations due to the physical nature of the debris, *atta* (whole wheat flour) was used.

Test Insects.—Adults of *Tribolium castaneum* were taken from a large population infesting a local grain store.

Procedure.—The insecticides were mixed with kaolin in order to form master mixtures, 0.25 gm. of insecticide being mixed with 33.08 gms. of kaolin. Three grams of a mixture of this master mixture and kaolin were then added to 140 gms. of *atta* in order to give insecticidal concentrations of 157, 105 and 53 parts per million. In addition, the grades of 16 per cent. and 4 per cent. *666*

in gypsum were mixed with kaolin to give an insecticidal concentration in the *atta* of 40 parts per million (Table I).

The mixtures were placed in standard battery jars, 5" diameter x 7" high, 50 test insects added and the mortality recorded daily.

Series I.—Insecticidal mixtures as shown in Table I were used and observations recorded during the first month (April, 1945.)

Series II.—Using the same *atta*, without any further addition of insecticides, the experiment was restarted with fresh adult insects, and observations recorded during the second month (May, 1945).

Series III.—A further test as above was carried out on the mixtures containing the highest concentrations of *DDT* and *666* during the third month (June, 1945).

Results.—Tables II, III and IV and the associated graphs in Fig. 1 show daily mortality of insects for Series I, II and III respectively.

Discussion

The results of experiments in Series I indicate that *DDT* (80 per cent. pp¹) is approximately as effective in killing *Tribolium castaneum* as *666* (10-12 per cent. γ -Benzene-hexachloride). *DDT*, 157 parts per million on the weight of *atta*, gave a 50 per cent. Kill in three days, which was approximately the same as the percentage kill given by *666* in similar concentration in the same time. At lower concentration the same relationships hold, with perhaps a slight tendency for *666* to be less effective than *DDT*.

The experiments with the *666* gypsum mixtures indicate that the *666* in this form was slightly less toxic than when the crude plant product was used. No importance can be attached to this result, however, as the

TABLE I. *Insecticide Concentrations*

Master mixture gm.	Kaolin gm.	Concentration in kaolin	Weight of debris <i>atta</i> gm.	Final concentration of insecti- cide in debris	
				%	p.p.m.
3.0	0.0	0.75	140	0.0157	157
2.0	1.0	0.50	140	0.0105	105
1.0	2.0	0.25	140	0.0053	53
0.075 (of 16% <i>666</i> in gypsum)	2.925	0.40	140	0.0084	84
0.30 (of 4% <i>666</i> in gypsum)	2.700	0.40	140	0.0084	84

TABLE II. *Total Mortality in 50 Tribolium castaneum at days from start.*
Series I.

S. No.	Treatment	Effective concentration in the final mixture %	1	2	3	4	5	7	8	9	10	11	12	14	15	16	17	18	19	21	22	23	24	25	26
1	DDT—0.75%	0.0157	1	5	26	32	34	38	40	42	—	44	45	48	—	—	49	—	50	—	—	—	—	—	—
2	DDT—0.50%	0.0105	—	3	11	18	26	30	31	32	—	33	34	36	—	—	37	—	—	39	—	40	—	—	—
3	DDT—0.25%	0.0053	1	3	6	12	15	20	21	—	23	24	—	26	—	—	—	—	—	—	27	—	28	29	—
4	666—0.75%	0.0157	2	14	24	25	32	38	39	40	—	41	—	43	—	—	44	—	—	—	—	—	—	—	—
5	666—0.50%	0.0105	—	2	9	14	17	20	22	—	—	—	23	24	—	—	—	25	—	25	—	—	26	—	—
6	666—0.25%	0.0053	—	2	7	13	16	18	19	—	—	—	21	23	24	—	—	—	—	24	—	—	25	26	—
7	666—0.40% reduced from 16% sample	0.0084	—	2	8	16	20	—	21	—	—	22	—	23	—	—	—	—	—	—	—	—	25	26	—
8	666—0.40% reduced from 4% sample	0.0084	—	3	7	—	12	13	14	—	—	15	16	18	19	—	—	—	—	20	—	—	—	—	—
9	Kaolin—100%	—	1	2	—	3	—	5	—	—	—	—	—	6	—	—	—	—	—	8	—	—	—	—	—
10	No treatment	—	—	1	—	3	—	4	—	—	—	5	—	6	—	—	—	—	—	8	—	—	—	—	9

TABLE III. Total Mortality in 50 *Tribolium castaneum* at days from start.

S. No.	Treatment	Effective concentration in the final mixture
1	<i>DDT-0.75%</i>	0.0157%;
2	<i>DDT-0.50%</i>	0.0105%;
3	<i>DDT-0.25%</i>	0.0053%;
4	<i>666-0.75%</i>	0.0157%;
5	<i>666-0.50%</i>	0.0105%;
6	<i>666-0.25%</i>	0.0053%;
7	<i>666-0.4%, reduced from 16% sample</i>	0.0084%;
8	<i>666-0.4%, reduced from 4% sample</i>	0.0084%;
9	Kaolin-100%	—
10	No treatment	—

999

566

(5 BENZENE HEXACHLORIDE 10-12%)

007

(pp' isomer 80%)

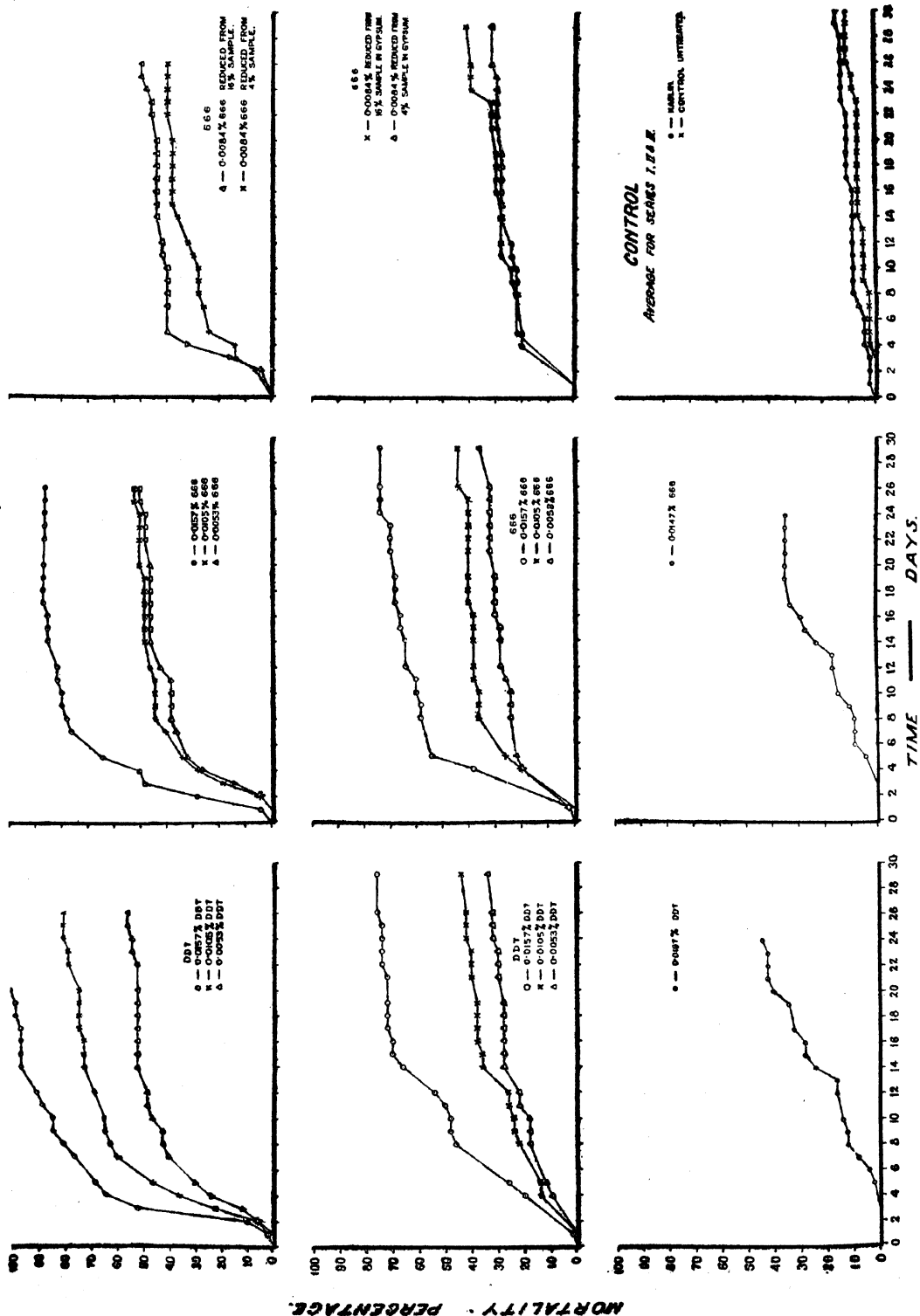


TABLE IV. Total Mortality in 50 *Tribolium castaneum* at days from start.

Series III.

S. No.	Treatment	Effective concentration in the final mixture	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24
1	DDT—0.75%	0.0157%	—	—	—	—	1	2	4	6	—	7	—	8	—	12	14	—	16	17	20	21	—	—	24
2	666—0.75%	0.0157%	—	—	—	—	2	4	—	—	5	7	—	8	—	11	13	14	16	17	—	—	—	—	22
3	Kaolin—100%	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2	3
4	No treatment	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2

actual quantities of 666 or the γ -isomer present in the samples were not estimated.

In the previous report¹ it was stated that 1 lb. of DDT would treat effectively approximately 20,000 lbs. of grain debris. (50 per cent. kill of *Tribolium castaneum* in approx. 20 days). The results obtained in these experiments indicate that 1 lb. of DDT in 20,000 pounds of *atta* would give a 50 per cent. kill in 3 to 4 days. Slade² states that 0.4 part per million of gammexane on the weight of grain gave a 50 per cent. kill of *Calandra granaria* in 5 days. This is a very much lower concentration than was required in the present experiments to give the same effect with *Tribolium castaneum*. The difference is probably mainly due to the fact that whole grain was used in the experiments reported by Slade, as previous results¹ have shown that there is little difference in the susceptibility of *Calandra* and *Tribolium* to DDT and 666.

It will be seen from Fig. 1 that in Series I and II the effect of both insecticides has completely worn off in approximately 14 days and that after this period the mortality is the same as in the controls. In Series III the effective period of the insecticides is slightly longer. It is suggested that the reason why the death rate decreases to zero in fourteen days in series I and yet when a fresh batch of insects are introduced in series II and III, increases rapidly, is due to the fact that any insects which can survive for a certain period may acquire a tolerance and/or that there is a variation in the resistance of the insects used. Further experiments are being carried out to elucidate this effect.

Conclusions

- (1) Kaolin mixed with grain debris (whole wheat flour) had no effect on the mortality of *Tribolium castaneum*.
- (2) 666 (10-12 per cent. benzene hexachloride) was approximately as effective as commercial DDT (80 per cent. pp¹) in effecting the sterilisation of grain debris infested with *Tribolium castaneum*.

References

- ¹ J. Sci. Ind. Res., 1945, 4, 73.
- ² Slade R., Hurter Memorial Lecture, 1945.

THE ISOLATION OF THYROXINE AND 'THYROXINE-CONCENTRATES' FROM INDIAN THYROID GLANDS

PART I

By B. B. DEY, P.S. KRISHNAN and M. GIRIRAJ

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THE isolation of thyroxine from the thyroid glands presents certain experimental difficulties which are not met with, say, in the case of the isolation of adrenaline from the suprarenal glands. No one has yet claimed a quantitative yield for thyroxine, although the yields of adrenaline are believed to be fairly quantitative¹. In fact, we are still in the dark as regards the actual thyroxine content of any given specimen of thyroid material. There is no biological method which will distinguish the potency of free thyroxine as distinct from the potency of iodothyroglobulin, of which the protein molecule thyroxine constitutes but one of the 'Bausteine'. Of the chemical methods of estimation of thyroxine proposed from time to time, the method of Harington and Randall² is based on the assumption that the acid-insoluble iodine from an alkaline hydrolysate of thyroid material is made up entirely of thyroxine iodine. Assays carried out by this method have yielded values ranging from 30 to 60 per cent. for thyroxine iodine, calculated on the basis of the total iodine of the samples of desiccated thyroid. The method of Leland and Foster³ which utilizes the selective extraction of thyroxine from alkaline hydrolysates by means of butyl alcohol yields values for the thyroxine-iodine content, which are much lower than the values given by Harington's method: these authors have shown that the acid-insoluble iodine is not made up entirely of thyroxine-iodine, an observation which fits in with the experimental results obtained also by Kendall⁴. Photometric determinations carried out by Brand and Kassel⁵, based on Millon's colour reaction, yielded the value of 39 for the percentage ratio between thyroxine iodine and total iodine of a sample of desiccated thyroid, whereas the corresponding value by the Harington and the Leland-Foster techniques were 50 and 29 respectively. Harington⁶ came to the conclusion that under normal conditions⁷ about 40 per cent. of the total iodine of the thyroid is thyroxine and the rest di-iodotyrosine. The

tendency of most of the modern authors is, however, to assess a lower level for the thyroxine iodine percentage: thus Grollman⁷ states that about a third of the iodine of the thyroid is bound as thyroxine, the remainder as di-iodotyrosine. With a value of 665,000 for the molecular weight of thyroglobulin and in the light of Bergmann's theory of protein structure, it has been calculated⁸ that the thyroglobulin molecule would contain 10 di-iodotyrosine molecules (that is, 20 iodine atoms) and two thyroxine molecules (that is, 8 iodine atoms): this would indicate that thyroxine iodine is only 8/28, that is, less than a third of the total iodine of the thyroid. As against this, the ultra-violet absorption studies of sheep thyroglobulin by Ginsel⁹ showed that the ratio, di-iodotyrosine-iodine/thyroxine-iodine cannot differ much from unity, that is, for every two molecules of di-iodotyrosine, there is one molecule of thyroxine. The whole question is further complicated by the fact that the ratio of thyroxine to di-iodotyrosine may not be a constant, but may fluctuate according to the metabolic requirements of the animal—a possibility which follows directly from the theory of the biogenetic synthesis of thyroxine from the di-iodotyrosine molecule¹⁰. The researches of Perlman, Morton and Chaikoff¹¹, using radioactive iodine as indicator of the metabolism of iodine, would, however, go to show that despite a good deal of fluctuation in the actual amount of labelled iodine deposited as thyroxine and di-iodotyrosine in the gland, the proportion of total labelled thyroid-iodine represented by each of these fractions remains fairly constant at each time interval. The highest yield of thyroxine yet reported has been only 16 per cent. of the total iodine, that is, one half the minimum possible thyroxine content. This low yield of thyroxine has to be attributed to the unavoidable destruction which attends all processes elaborated so far for the isolation of the hormone, both during the process of hydrolysis and during the subsequent stages

of purification. Thompson *et al.*¹² have shown that heating with alkali destroys about three-fifths to four-fifths of the calorogenic activity of desiccated thyroid.

Methods of Isolation of Thyroxine

As has already been mentioned, thyroxine does not occur free in the thyroid gland, but is present as one of the amino-acid constituents of the thyroglobulin molecule. Any method of isolation would, therefore, involve hydrolytic fission of the protein molecule.

(1) *Enzymic digestion*: Practically the whole of the iodine of the thyroid gets converted into inorganic iodine during treatment with enzymes. The method has only theoretical significance, in so far as thyroxine can be isolated in the optically active form from thyroid material only by methods of enzyme digestion. Working with several kilograms of thyroid glands Harington¹³ was able to isolate a few milligrams of *levo* thyroxine. In the hands of Foster, *et al.*¹⁴ successive action of peptic, tryptic and ereptic enzymes on over 18 kg. of fresh hog thyroid yielded but 104 mg. of pure *levo* thyroxine: in a second trial they reported a yield of 28 mg. of *levo* thyroxine from 2.2 kg. of commercial desiccated thyroid.

(2) *Acid hydrolysis*: No one has yet succeeded in isolating thyroxine by acid hydrolysis of thyroid material. Digestion with sulphuric acid yields 'Iodothyrim'¹⁵ which is physiologically potent, but attempts at the isolation of the pure hormone from this fraction have not met with success. It might be pointed out that acid hydrolysis of artificially prepared iodoproteins has met with signal success at the hands of Reinecke and Turner¹⁶: by hydrolysis with sulphuric acid-butyl alcohol mixture these authors isolated *levo* thyroxine in yields of 0.1 per cent. from iodocasein.

(3) *Alkaline hydrolysis*: (a) *Hydrolysis with sodium hydroxide*: Thyroxine was isolated first by Kendall¹⁷ in pure crystalline condition by alkaline hydrolysis of the gland substance. Fresh glands were hydrolysed by boiling with 5 per cent. sodium hydroxide, fats were removed by chilling and salting out and the resulting clear solution was acidified. The acid insoluble precipitate was collected, dissolved in 95 per cent. alcohol with the aid of hydrochloric acid, the solution neutralized by the addition of sodium hydroxide and tarry impurities removed by filtration. Further impurities were eliminated

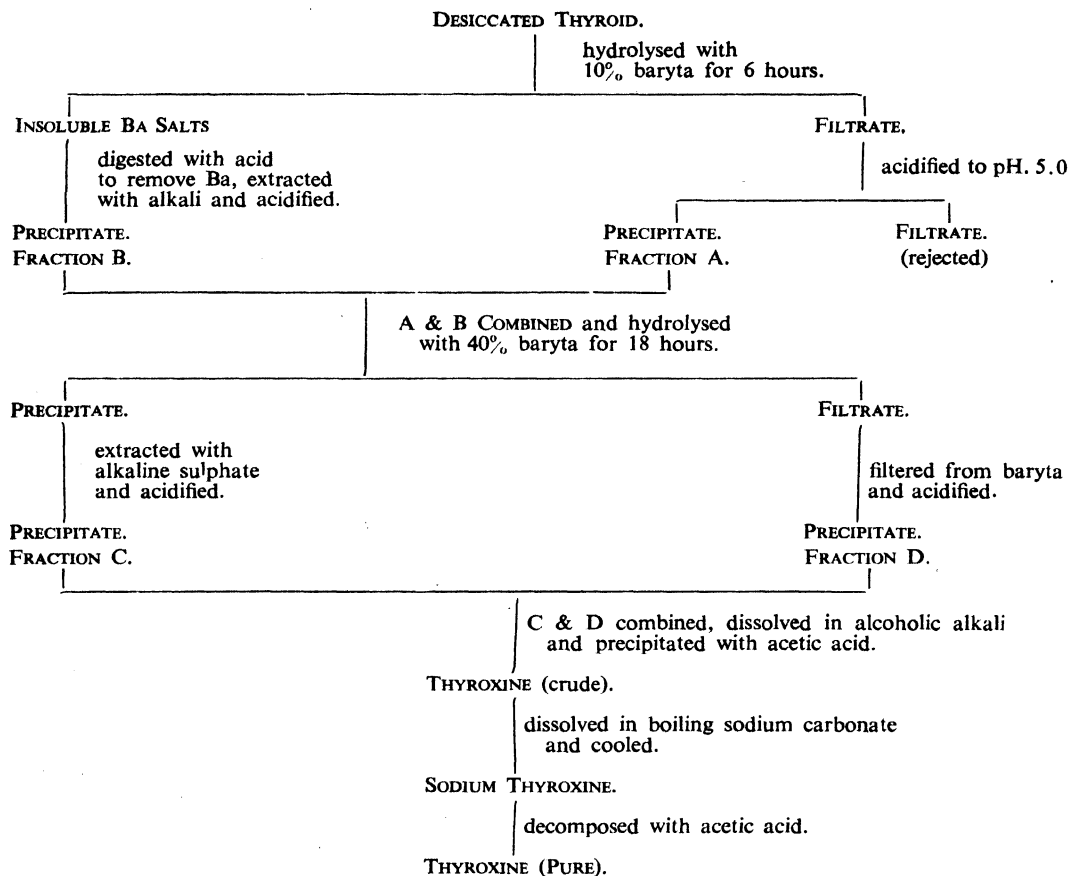
by treatment of the neutralized alcoholic solution with saturated baryta, followed by a period of more intensive hydrolysis: the filtrate was treated with sodium hydroxide and saturated with carbon dioxide and the alcohol distilled off, when there separated on keeping crystalline sodium thyroxine, which could be converted into free thyroxine by acidification.

The amount of thyroxine finally isolated was minute, in spite of the fact that the acid insoluble fraction represented as much as 50 per cent. of the total iodine. The yield from 3 tons of pig thyroid was only 33 grs. of the pure product, that is, a yield of about 0.0011 per cent. on the basis of the weight of fresh glands: expressing the same in terms of iodine, about 2 per cent. of the thyroid-iodine was obtained in the form of thyroxine.

Kendall's method of hydrolysis with sodium hydroxide has not met with much popularity and has been for the most part replaced by Harington's method of baryta hydrolysis. It might, however, be mentioned that Leland and Foster³ applied the butyl alcohol method of extraction for the isolation of thyroxine from a sodium hydroxide hydrolysate of thyroglobulin: the yield was far from quantitative.

(b) *Hydrolysis with barium hydroxide*: Hydrolysis of desiccated thyroid with graded strengths of baryta was utilized by Harington¹⁸ for the isolation of thyroxine according to the scheme represented in the following page. It might also be mentioned that thyroxine was first isolated from artificially iodinated proteins by hydrolysis with baryta.¹⁹ Harington obtained from desiccated thyroid a yield of 0.12 per cent. of thyroxine which would correspond to a yield of 0.027 per cent. on the basis of the weight of the fresh glands, as compared with 0.0011 per cent. obtained by Kendall. Yet Harington's best yield corresponds to only 16 per cent. of the iodine present as against 2 per cent. obtained by Kendall. Harington's yield was confirmed by Foster²⁰ who hydrolysed iodothyroglobulin directly with 40 per cent. baryta and obtained thyroxine in yields of 16 per cent. of the total iodine.

Immediately after the publication of Harington's investigations, Kendall²¹ re-investigated the isolation of thyroxine by both his method of sodium hydroxide



(The terms 'A', 'B', 'C' and 'D' have been assigned by the present authors, for convenience in describing the experiments in the following pages.)

hydrolysis and Harington's baryta hydrolysis method, as a result of which the following conclusions were arrived at:—

(i) Sodium hydroxide does not have a greater destructive effect on thyroxine than barium hydroxide: controlled experiments with English desiccated thyroid in which the material was treated by both Harington's and Kendall's methods yielded practically the same amount of thyroxine. Kendall effected certain modifications in his original method and reported the highest yield of thyroxine ever recorded in literature: working with thyroid glands of sheep which had been fed iodine for nine months and whose iodine content was over 1 per cent. he obtained thyroxine in yields of 0.4 per cent. of the dry weight of the glands.

(ii) Thyroxine could not be separated from all samples of *desiccated* thyroid which contain iodine. All samples of *fresh* thyroid material, however low the iodine content may be, uniformly yield at least traces of thyroxine: however, many samples of *desiccated* thyroid (some from England and others from America) would not yield any thyroxine whatsoever, either by Harington's or by Kendall's method, although the iodine content was as high as 0.5 per cent. and the dried glands were quite potent as estimated physiologically. He assumed that thyroxine undergoes some chemical change during desiccation of fresh thyroid, which does not influence its physiological potency, but which makes impossible the separation of thyroxine in crystalline form.

(iii) The use of barium hydroxide as described by Harington does not furnish a satisfactory method for the isolation of thyroxine from *all* samples of thyroid material. Samples of desiccated thyroid prepared in England readily yielded to the process, but several samples of desiccated American hog thyroids gave rise to considerable experimental difficulties. The '*A*' *Fraction*, with slight modifications, could always be worked up for the isolation of thyroxine, but the '*B*' *Fraction* was extremely refractory and no thyroxine at all could be isolated: this fraction was obtained in voluminous amounts and on treatment with sodium hydroxide, gelatinous solutions were obtained which could neither be filtered nor centrifuged. Kendall explained this difference on the basis of chemical differences in the composition of American and English thyroids.

(iv) Harington's statement that the 40 per cent. barium hydroxide solution after the removal of the Ba-insoluble material was of no further value as regards the isolation of thyroxine was contradicted by Kendall. Hydrolysing 2 kg. desiccated thyroid (the total iodine content of which was 0.34 per cent.) by Harington's method, Kendall obtained 590 mg. of *Fraction C* containing a total of 294 mg. of iodine and 1,570 mg. of *Fraction D* containing a total of 522 mg. of iodine. Although both these fractions did not yield thyroxine by Harington's method, a modified technique was devised by means of which 185 mg. and 250 mg. respectively of pure crystalline thyroxine could be separated from *Fraction C* and *Fraction D*.

(v) There was a seasonal variation in the yield of thyroxine: the amount which could be isolated during the winter months was only about a fifth of the yield obtained during the summer months.

The above-mentioned issues raised by Kendall have been left practically unanswered by Harington, although he introduced certain minor modifications²² in the treatment of the *B Fraction* and the working up of the 40 per cent. barium hydroxide soluble fraction.

The investigations of the present authors on the isolation of thyroxine from thyroid glands obtained from the local slaughter-houses have brought to light several interesting facts, some of which corroborate Harington's observations and others support Kendall's contentions. The starting material

was in all cases desiccated thyroid prepared from the glands obtained from the Corporation Slaughter House, Madras, and it was found that hydrolysis with baryta was better suited for the isolation of thyroxine than hydrolysis with sodium hydroxide. Thyroxine could be isolated from all specimens of desiccated thyroid, irrespective of whether cattle, sheep or pig thyroid was used as starting material. No appreciable seasonal variation in the yield of thyroxine was observed, which is quite in keeping with the constancy in the total iodine content of thyroid glands collected in India throughout the seasons of the year²³. However, working up of *Fraction B* was beset with considerable experimental difficulties and the net yield of thyroxine was thereby reduced appreciably. In the hope that isolated thyroglobulin, as distinct from desiccated thyroid, might not offer the same experimental difficulties as were experienced with the latter, the protein was separated from fresh cattle glands and subjected to the same process of hydrolysis: however, practically the same difficulties were encountered in working up *Fraction B* and *Fraction D*. Foster²⁰ had claimed that by directly hydrolysing thyroglobulin with 40 per cent. baryta, thyroxine could be recovered from the baryta-soluble fraction in yields of 16 per cent. of the total iodine: in the hands of the present authors, however, such a hydrolysis was attended with the presence in appreciable quantities of acid-insoluble iodine in the Ba-insoluble precipitate also.

Experimental

Preparation of desiccated thyroid: Thyroid glands dissected out from the carcasses soon after slaughter in the Corporation Slaughter House, Madras, were transported to the laboratory in melting ice: they were trimmed free from fat and connective tissue, minced, spread in thin layers and dried at a temperature of 60° C., part in contact with atmospheric air in an ordinary air-oven and the rest in a vacuum chamber out of contact with air. The dried solids were separately ground, packed loosely in a soxhlet apparatus and extracted with acetone for the removal of fat. The residual solid was in each case dried *in vacuo* to remove the last traces of acetone and ground in a laboratory mill, whereby a finely divided, fairly white powder was obtained with a characteristic odour. In the case of pigs, only small numbers of which are slaughtered daily

TABLE I. *Desiccation of Thyroid Glands.*

	Av. wt. of fresh glands. gms.	Moisture content of glands. %	Fat cont. of dried glands. %	Yield of desiccated powder (% of fresh glands).	Total iodine (% of desiccated powder).	Thyroxine iodine (% of des. powder)	Ratio Total I Thyrox. I
Cattle	7—10	75—80	4—6	20—25	0.85—1.00	0.35—0.40	35—40
Sheep	1.5—2.5	75—80	4—6	20—23	0.65—0.75	0.25—0.30	35—40
Pigs	3—5	73—78	15—25	18—20	0.70—0.85	0.30—0.40	40—45

in Madras, the desiccated powder had to be accumulated over a period of months: there was, however, no risk of deterioration in potency, since investigations carried out in these laboratories²⁴ had proved that desiccated thyroid was remarkably stable even at the laboratory temperatures. Analyses of total and thyroxine iodine by the *B.P.* methods carried out on the various specimens of desiccated thyroid powder are included in Table I.

As has already been pointed out²⁵, the thyroid glands of Indian animals are small in size compared to the glands of animals slaughtered in western countries: however, the desiccated thyroid processed from the local glands possess an unusually high iodine content. When a comparison is made with the figures quoted by Corran, Pritchard and Rymill²⁶ for the analyses of fresh English thyroid and the frozen glands from Argentine, it will be noted that the moisture content of the Indian glands is rather high and the fat content correspondingly low, so that the final yield of desiccated powder is almost the same in all cases.

Isolation of thyroglobulin: The method of preparation was essentially the same as that described by Harington²². Frozen thyroid was minced and extracted with 1 per cent. sodium chloride containing 0.02 per cent. sodium hydroxide: the extract, after cooling and mechanical removal of fat, was adjusted to pH. 5, sodium sulphate added to a concentration of 1 per cent. and the solution rapidly raised to boiling point so as to coagulate the proteins. The material was filtered on a large Buchner funnel, washed with water and dried with repeated charges of acetone. A fine white powder was obtained, which was dried *in vacuo* to remove the last traces of acetone. The yields of thyroglobulin from cattle, sheep and pig glands and the respective

iodine contents are represented in the following table (Table II).

TABLE II. *Isolation of Iodothyroglobulin*

Source of gland.	Yield of protein %	Iodine content of protein %
Cattle	(a) 20.7 (b) 19.2 (c) 18.0	1.166 1.062 1.023
Sheep	(a) 11.5 (b) 12.4 (c) 10.0	0.839 1.016 0.952
Pig	(a) 14.9 (b) 13.7 (c) 13.0	0.803 0.871 0.937

Hydrolysis of desiccated thyroid and thyroglobulin: The hydrolysis with 10 per cent. baryta was carried out either in 250 gm. lots, when the intermediate fractions from four separate experiments were combined and worked up for the second stage hydrolysis with 40 per cent. baryta or directly in 1-kg. lots, when the hydrolysis was carried out in 20-litre pyrex flasks. The method was essentially the same as that described by Harington¹⁸. To describe a typical experiment, 1 kg. of cattle desiccated thyroid was added to a boiling solution of 1 kg. of crystalline barium hydroxide and the mixture kept thoroughly stirred until boiling commenced. After 6 hours' boiling, the mixture was allowed to cool overnight. The clear supernatant liquid was siphoned off and the residual solid filtered on a Buchner funnel and washed thoroughly with water. The combined filtrate and supernatant liquid were acidified with concentrated hydrochloric acid (about 600 to 800 c.c.) until the pH. was acidic to congo red, the mixture being kept vigorously stirred mechanically during acidification. A yellowish white flocculent precipitate was formed which was filtered the next day and washed with water on the Buchner. The material (Fraction A) was dried *in vacuo*

over sulphuric acid at the ordinary temperature, since elevation of temperature was found to colour the material.

The residual solid, which was insoluble in 10 per cent. baryta, was treated in the following manner. Preliminary experiments had shown that Harington's method of alkaline sodium sulphate treatment yielded colloidal solutions which could not be satisfactorily filtered or centrifuged. The moist solid was, therefore, ground up, suspended in water, heated to boiling point and the barium salts decomposed by the addition of concentrated hydrochloric acid (70 to 90 c.c.) until the pH. was distinctly acid to congo red. The precipitate (Fraction B) which settles very easily was filtered off, washed with water and dried in *vacuo* over sulphuric acid at a temperature of 50° C. Fraction A was usually pale yellowish in colour with a characteristic odour, whereas Fraction B was clayish in colour with a different but equally characteristic odour.

The B fraction, especially, was found to contain material which could be extracted with petroleum ether: in all cases, therefore, Fraction A and Fraction B were soxhleted with petroleum ether. There was practically no loss of iodine during the process, but about 10 to 15 per cent. of material was extracted in the case of Fraction B and about 1 to 5 per cent. in the case of Fraction

A. Analyses of the resulting powders are given in Table III.

In another series of experiments the isolated thyroglobulin was subjected to the same process of hydrolysis with 10 per cent. baryta, as in the case of desiccated thyroid: Fractions A and B were worked up separately. In still a third series of experiments the thyroglobulin was hydrolysed direct with 40 per cent. baryta according to the technique of Foster²⁰ and the soluble and insoluble material worked up separately. These values also are given in Table III.

It will be apparent from the table that

- (i) When desiccated thyroid is hydrolysed with 10 per cent. baryta, the acid-insoluble (thyroxine) iodine gets distributed between two different fractions, *Fraction A* and *Fraction B*, the former containing 25 to 30 per cent. and the latter 14 to 17 per cent. of the total iodine. Fraction A is about 2 to 3 times as concentrated in iodine as Fraction B.
- (ii) On hydrolysis with 10 per cent. baryta, cattle thyroglobulin also yields the same two fractions: about 32 per cent. of the total iodine is present in Fraction A and about 14 per cent. in Fraction B. On subjecting thyroglobulin to hydrolysis with 40 per cent. baryta, 17-19 per cent. of the total

TABLE III. *Hydrolysis of Desiccated Thyroid with 10% baryta for six hours.*
(1 kg. of material in each case)

Source	Method of drying	Iodine content %	Total iodine in starting material mgm.	Fraction A			Total iodine in Fraction A %	Fraction B			Total iodine in Fraction B %
				Yield gm.	Iodine content %	Total iodine mgm.		Yield gm.	Iodine content %	Total iodine mgm.	
Cattle	Vacuum	0.9010	9,010	34.5	7.923	2,733	30.34	43.5	3.690	1,605	17.81
	"	0.9601	9,601	34.26	8.492	2,908	30.31	37.24	3.665	1,365	14.22
	"	0.9272	9,272	26.0	9.673	2,515	27.06	45.05	3.324	1,497	16.14
	Air	0.9461	9,461	32.0	7.770	2,486	26.28	46.0	3.603	1,658	17.52
	"	0.9346	9,346	28.5	8.840	2,520	26.97	43.06	3.443	1,483	15.87
	"	0.9104	9,104	28.8	8.752	2,498	27.45	43.38	3.802	1,649	18.11
Sheep	Vacuum	0.6974	6,974	26.36	7.276	1,918	27.51	42.67	2.695	1,150	16.49
	Air	0.6377	6,377	23.96	6.906	1,655	25.95	48.00	2.180	1,047	16.42
	"	0.6377	6,377	25.22	6.825	1,721	26.99	48.00	2.180	1,047	16.42
	"	0.5907	5,907	22.32	6.829	1,524	25.79	46.45	2.16	1,003	16.98
Pig	Vacuum	0.7741	7,741	29.00	8.00	2,320	29.97	37.0	3.547	1,312	16.94
	"	0.8149	8,149	29.00	8.00	2,320	28.47	31.38	3.618	1,135	13.93
	"	0.7335	7,335	29.96	7.037	2,109	28.75	34.2	4.039	1,381	18.82
	"	0.7582	7,582	28.32	8.104	2,295	30.27	34.72	3.242	1,126	14.85
Thyroglobulin from cattle		1.116	11,160	50.18	7.215	3,620	32.44	71.95	2.252	1,620	14.52
(1) Hydrolysed with 10 per cent. Baryta (Harington's procedure)		1.022	10,220	11.19	16.82	1,879	18.4	76.1	0.6509	495	4.85
(2) Hydrolysed with 40 per cent. Baryta for 18 hours (Foster's method)		1.022	10,220	10.30	18.81	1,937	18.95	71	0.6030	428	4.19

iodine passes into Fraction A and 4.5 per cent. into Fraction B. Foster's experiments could not, therefore, be confirmed.

Harington has not reported the yields and the compositions of the various intermediate fractions, so that no comparisons could be drawn between the yields obtained by the present authors and by Harington.

Treatment of Fraction B:—Fraction B was characterized by a high percentage of ash content: thus it had an ash content of 20.30 per cent. as compared with 2.5 per cent. for Fraction A. After various trials an elegant method was worked out for effecting the preliminary purification of this fraction. The material was suspended in alcohol, made alkaline with sodium hydroxide, and boiled under reflux for 30 to 60 minutes, during which process practically the whole iodine passed into solution leaving behind all the inorganic and part of the organic impurities. The undissolved material was filtered off and the filtrate concentrated in *vacuo* to remove the alcohol and the residual material diluted with water and acidified to pH. 4.5 with hydrochloric acid and the precipitate granulated by heating. The material was filtered at the pump, washed with water and dried in *vacuo*. The iodine content of the fraction was found to have risen from the original value of 3 to 3.5 per cent. to a final value of 6 to 7 per cent.

From Harington's statement it was to be expected that treatment of this fraction with 40 per cent. baryta would lead to the isolation

of crystalline thyroxine. This, however, was not the case: a fraction was obtained which contained about 16 per cent. iodine and from which thyroxine could not be crystallized by the ordinary methods. Detailed investigations carried out on this fraction will be reported in Part 2 of this series. It might be recalled in this connection that Kendall could not isolate any thyroxine from Fraction B.

Treatment of Fraction A: The A fraction obtained from 1 kg. of desiccated thyroid was dissolved in 500 c.c. of distilled water with the aid of a little ammonia and the excess of the latter boiled off. 200 gms. of crystalline baryta were added and the mixture heated for 18 hours on the steam bath. The mixture was filtered hot through a steam jacketed Buchner funnel and the residual solid (Fraction C (a)) was washed with hot water. The filtrate was allowed to cool in the frigidaire, filtered off from the separated baryta crystals, acidified to pH. 4.5 with hydrochloric acid and the precipitate formed granulated by heating. The material (Fraction D) was filtered at the pump, washed with water and dried in *vacuo*. Fraction C (a) was ground up and suspended in 500 c.c. of 1 per cent. sodium hydroxide: the solution was heated to boiling and treated with a strong solution of sodium sulphate in excess and the solution filtered from the precipitated barium sulphate. The filtrate was brought to the boil and while boiling treated with 50 per cent. sulphuric acid until the pH. was just acid to congo red. On continuing to boil for a minute or two more, the character of

TABLE IV. *Hydrolysis of Fraction A with 40 per cent. Baryta for 18 hours.*

Source and Mode of drying	Total iodine in Fraction A mgm.	Fraction C			% total iodine of Fraction A present in Fraction C	Fraction D			% total iodine of Fraction A in Fraction D	% iodine of desiccated gland in Fraction D
		Yield gms.	Iodine content %	Total iodine mgm.		Yield gm.	Iodine content %	Total iodine mgm.		
<i>Cattle—</i>										
Vacuo	2,733	1.7	52.2	887	32.45	1.09	31.45	343	12.54	3.81
"	2,908	2.28	50.91	1,161	39.91	0.68	31.72	219	7.42	2.18
"	2,515	1.89	50.05	946	37.61	1.54	21.62	333	13.24	3.59
Air	2,486	1.96	52.23	1,023	41.13	1.38	22.34	308	12.39	3.26
"	2,520	1.86	44.8	833	33.03	1.75	20.11	352	13.96	3.77
"	2,498	2.24	47.36	1,061	42.47	1.42	21.88	311	12.46	3.42
<i>Sheep—</i>										
Vacuo	1,918	1.51	44.35	670	34.93	1.34	21.73	291	15.17	4.17
Air	1,655	1.20	49.71	597	36.16	1.134	26.72	303	18.31	4.75
"	1,721	1.22	44.25	539	31.39	0.98	36.67	359	20.86	5.63
"	1,524	1.25	42.8	535	35.12	0.970	26.69	259	17.00	4.38
<i>Pig—</i>										
Vacuo	2,320	2.32	44.0	1,019	43.9	1.474	20.42	301	12.97	3.89
"	2,320	1.64	44.71	733	31.59	0.96	35.96	346	14.91	4.25
Air	2,109	1.68	43.46	730	34.61	0.800	35.96	288	13.66	3.93
"	2,295	1.75	43.53	763	33.20	1.452	38.36	555	24.18	5.82
<i>Cattle—</i>										
thyroglobulin	3,620	2.73	47.67	1,300	35.91	2.561	22.84	586	16.15	5.25

the precipitate changed: at first light and flocculent, it became heavy and granular; as soon as this change occurred, the boiling was stopped and the mixture cooled. The solid material was filtered off, washed with water and dried in *vacuo*. A pale yellow powder (Fraction C) was obtained.

Analyses carried out on Fraction C and Fraction D are represented in Table IV, from which it will be clear that when Fraction A is submitted to the second stage hydrolysis with 40 per cent. baryta, the acid insoluble (thyroxine) iodine gets distributed again into two different fractions: Fraction C and Fraction D, the former containing 30 to 40 per cent. and the latter 10 to 20 per cent. of the total iodine in Fraction A. Fraction C is about twice as concentrated in iodine as Fraction D.

Treatment of Fraction D: Harington first thought that the 40 per cent. barium hydroxide soluble fraction was of no further value as regards the isolation of thyroxine: but later he stated that acidification of the solution to pH. 4.5 yielded a certain amount of precipitate, an alkaline extract of which was combined with the main fraction and worked up for the isolation of thyroxine. Preliminary investigations with Fraction D obtained by the present authors showed that processing for the isolation of crystalline thyroxine was beset with considerable experimental difficulties, as was also experienced by Kendall, who reported that thyroxine added to Fraction D could not be recovered by the ordinary methods of crystallization. As a rule, therefore, the D fractions were not mixed with the C fractions but were separately processed for the isolation of thyroxine.

The results of the investigations of the present authors on Fraction D will be reported in Part 2 of this series.

Fraction C: Harington dissolved the solid in sodium hydroxide, added alcohol to 80 per cent. concentration, filtered from a small amount of tarry material and treated the filtrate in the boiling condition with 33 per cent. acetic acid, whereupon thyroxine separated in partially crystalline form. Kendall, however, could not repeat these observations: on addition of acetic acid to the alkaline alcoholic solution, no thyroxine separated. The experience of the present authors has been that on acidification of the alkaline alcoholic solution and keeping overnight in frigidaire a small amount (200 to

300 mg.) of a dark coloured product was obtained as the first crop: this was centrifuged and dried; and the iodine content was found to be 30 to 40 per cent. The supernatant liquid on concentration in *vacuo* and standing at frigidaire temperature, yielded about 1 gm. of a pale brown solid which analysed 40 to 50 per cent. iodine and which obviously represented the main thyroxine fraction. Still a third fraction analysing about 30 per cent. iodine and in yields of about 300 mg. per kg. of desiccated powder could be obtained by further concentration of the mother liquor: this fraction was highly impure and was found to be resistant to further purification.

As a result of a series of trials the following procedure was finally adopted for the treatment of Fraction C. 1.4 to 2 gm. of the solid (which was pale white in colour), representing the yield from 1 kg. of desiccated thyroid, were suspended in about 160 to 180 c.c. of 80 per cent. alcohol, heated on the steam bath and brought into solution by the addition of about 15 to 20 c.c. of normal sodium hydroxide. There was no necessity for filtration since a perfectly clear solution was obtained: but the solution rapidly assumed a deep brown colour. The solution was acidified in the hot by the addition of about 5 to 7 c.c. of 33 per cent. acetic acid, until the pH. was 4.5 to 5: the mixture was kept heated on the steam bath for about 15 minutes longer, whereupon a solid material was observed to separate out: fairly white flakes of crystals were always found to get mixed with brownish coloured particles: the mixture was set aside in the frigidaire for two days and then the solids were separated by centrifuging: the residue was washed with ice cold alcohol and dried in a vacuum desiccator. The pale brown powder so obtained represented the major fraction of thyroxine. The supernatant liquid was concentrated in *vacuo* at a temperature of 45 to 50° C. and cooled in the frigidaire, when there separated another solid fraction which was slightly less coloured than Precipitate 1. The mother liquor on further concentration yielded fractions having low iodine contents: these were usually rejected. The data obtained by processing Fraction C are given in Table V.

It will be evident from the table that in the case of cattle desiccated thyroid, about 70 per cent. of the total iodine in Fraction C gets concentrated in Precipitate 1, which

has an iodine content of 58 to 62 per cent. : in the case of sheep and pig desiccated thyroid, Precipitate 1 contains about 58 to 70 per cent. and 55 to 61 per cent. respectively of the total iodine in Fraction C. Considering Precipitate 1 as representing crude thyroxine, the yield of the product would work out to 0.1 to 0.14 per cent. 0.07 to 0.08 per cent. and 0.08 to 0.1 per cent. respectively on the basis of the weight of desiccated cattle, sheep and pig thyroid: the amount of iodine in this fraction would represent about 5 to 8 per cent. of the total iodine in desiccated thyroid. As has already been mentioned, Precipitate 1 was slightly coloured: redissolving in alkaline alcohol and reprecipitation with acetic acid did not improve materially either the colour or the iodine content. The fraction was, therefore, directly treated for the isolation of sodium thyroxine by the method of Harington.

Precipitate 2 contained about 20 to 30 per cent. of the total iodine in Fraction C, the

iodine content being about 40 per cent. Though the colour of this fraction was lighter than that of Precipitate 1, it was found in the case of sheep and pig thyroids that no appreciable improvement in the iodine content could be effected by the ordinary methods of purification. The data presented in Table VI would show that when the fraction is dissolved in alkaline alcohol and treated with acetic acid in the hot, two fractions are obtained, one which gets precipitated when the solution is left in the frigidaire overnight, and a second fraction which separates on concentration of the mother liquor *in vacuo*: the iodine content of these two fractions was, however, not much higher than that of the starting material. Further investigations on this fraction will be reported in Part 2 of this series.

In the case of Precipitate 2, derived from cattle thyroid, however, purification of the fraction was feasible to an extent: after alkaline alcohol-acetic acid treatment, frac-

TABLE V. *Treatment of Fraction C.*

Source and mode of drying	Fraction C		Precipitate I (precipitated immediately)			% Iodine of Fraction C in Ppt. I.	Precipitate II.			Iodine % of Fraction C in Ppt. II	Total iodine in desiccated gland mgm.	% of iodine of desiccated gland in Ppt. I	% yield of crude thyroxine	% of iodine of desiccated gland in Ppt. II.
	Yield gms.	Total iodine mgm.	Yield gm.	Iodine content %	Total iodine mgm.		Yield gm.	Iodine content %	Total iodine mgm.					
Cattle—														
Vacuo	1.7	887	0.994	60.67	603	68.0	0.579	47.8	277	31.2	9,010	6.7	3.07	
"	2.28	1,161	1.42	60.87	864	74.4	0.602	41.36	249	21.44	9,601	8.99	2.59	
"	1.89	946	1.08	59.2	640	67.6	0.684	42.04	288	19.97	9,272	7.56	3.10	
Air	1.96	1,023	1.224	62.19	761	74.4	0.638	46.77	297	29.04	9,461	8.04	3.14	
"	1.86	833	0.959	58.37	560	67.2	0.635	41.98	267	32.00	9,346	5.99	2.86	
"	2.24	1,061	1.348	58.61	790	74.5	0.587	42.78	251	23.66	9,104	8.68	2.76	
Sheep—														
Vacuo	1.51	670	0.779	54.78	427	63.68	0.590	38.28	226	33.71	6,974	6.12	3.24	
Air	1.20	597	0.702	52.91	372	62.30	0.410	33.18	136	22.78	6,377	5.83	2.13	
"	1.22	539	0.714	52.91	378	70.09	0.417	33.18	138	25.66	6,377	5.93	2.16	
"	1.25	535	0.728	48.05	350	65.36	0.400	33.98	136	25.40	5,907	5.92	2.30	
Pig—														
Vacuo	2.32	1,019	1.086	52.3	568	55.76	1.062	36.88	392	38.49	7,741	7.34	5.06	
"	1.64	733	0.768	52.3	402	54.80	0.750	36.88	277	37.74	8,149	4.93	3.40	
Air	1.68	730	0.870	51.41	447	61.28	0.703	36.56	257	35.21	7,335	6.10	3.50	
"	1.75	763	0.907	51.41	466	61.12	0.733	36.56	268	35.14	7,582	6.15	3.53	
Cattle—														
Thyroglobulin	2.73	1,300	1.4	54.09	757	58.25	0.998	39.42	393	30.26	11,160	6.78	3.52	

TABLE VI. *Fractionation of Precipitate 2 (solution in alkaline alcohol and precipitation with acetic acid)*

Source	Precipitate 2			First crop		Second crop		
	Iodine content %	Total I mgm.	Yield mgm.	Iodine content %	Total I mgm.	Yield mgm.	Iodine content %	Total I mgm.
Cattle—								
977 mg.	37.45	366	235	55.58	131	567	37.39	212
1,284 mg.	40.73	523	320	53.31	171	825	36.42	300
Sheep—								
1,480 mg.	32.85	486	200	36.7	73	1,140	35.5	405
Pig—								
710 mg.	34.41	244	70	38.7	27	530	37.53	199

tions were obtained, having an iodine content of 53 to 55 per cent. However, the major part of the iodine was present in the second crop (*vide* Table VI), whose iodine content was only 36 to 37 per cent.

It will also be apparent, from Table V, that only a small fraction (about 5 to 10 per cent.) of the total iodine in Fraction C gets lost in the final mother liquor, after separation of Precipitate 2.

Isolation of Sodium Thyroxine

Precipitate 1 was dissolved in boiling 0.5 per cent. sodium carbonate solution, in the proportion of 75 to 85 c.c. of the solution per gram of the solid: the solution was complete in almost all cases and there was no need to filter. After standing overnight in the frigidaire the crystals of sodium thyroxine were separated at the centrifuge, washed with a small quantity of ice cold dilute sodium carbonate solution and dried in a vacuum desiccator. A perfectly white specimen was obtained in yields corresponding to 60 to 75 per cent. of the total iodine of the starting material and having an absolute iodine content of 61 to 63 per cent. On concentration of the mother liquor in *vacuo* at a temperature of about 50° C. and keeping the resulting solution for a couple of days at the frigidaire temperature, a second crop of sodium thyroxine crystals were obtained, in yields representing 8 to 10 per cent. of the total iodine in starting material: the product was, however, impure, being slightly coloured and having an iodine content of only 54 to 58 per cent. The residual mother liquor on acidification yielded a pale brown solid, having an iodine content of 36 to 42 per cent. Quantitative data are represented in Table VII.

In another series of experiments, sodium thyroxine was sought to be isolated directly from Fraction C, without subjecting the latter to the intermediate stage of fractionation by the alkaline-alcohol-acetic acid treatment. Sodium thyroxine was obtained, as before, in two crops—the main crop coming down on cooling the hot solution of Fraction C in sodium carbonate and the second crop on concentration of the mother liquor in *vacuo*. The final mother liquor yielded on acidification a coloured fraction having an iodine content of 35 to 45 per cent. Quantitative data are included in Table VII.

TABLE VII. Isolation of Sodium Thyroxine.

Source	Precipitate 1.			First crop of Na salt			% of total iodine in first crop	Second crop of sodium salt			% of Tot. I. in second crop	Residual solid obtained from mother liquor			
	Yield mgm.	Iodine content %	Total I. mgm.	Yield mgm.	Iodine content %	Total I. mgm.		Yield mgm.	Iodine content %	Total I. mgm.		Yield mgm.	Iodine content %	Total I. mgm.	% of Total I. in residual solid
Cattle	3300	53.22	1756	2110	62.0	1308	74.5	330	55.08	182	10.4	760	36.91	281	16.0
"	3700	57.0	2109	2500	61.0	1535	72.3	300	56.0	168	8.0	800	36.85	316	14.0
"	223	60.22	134	138	62.95	87	65.0	40	58.0	23	13.7	62	38.20	24	17.6
"	537	59.20	318	401	61.77	248	77.8	27	58.92	16	5.0	95	42.71	41	12.9
Sheep	2370	48.92	1160	1140	61.99	707	60.9	190	54.93	104	9.0	780	39.79	310	26.6
Pig															
Fraction C.															
Cattle	860	50.55	435	471	62.01	292	67.2	43	54.37	23	5.3	257	35.74	92	21.2
"	643	50.91	327	334	62.5	209	63.8								
"	646	44.80	289	260	62.46	162	56.1					161	45.57	73	25.3
"	595	52.20	311	323	62.15	201	64.6								

When it is remembered that Precipitate 1 represents only 60 to 70 per cent. of the total iodine of Fraction C, it will be obvious that the proportion of total iodine recoverable as sodium thyroxine by direct treatment of Fraction C with sodium carbonate, compares very favourably with, if not better than, that obtainable by preliminary fractionation of Fraction C and subsequent treatment of Precipitate 1 with sodium carbonate.

Solution of sodium thyroxine in alkaline alcohol and acidification in the hot with 33 per cent. acetic acid, resulted in practically quantitative yields of pure crystalline thyroxine, with the correct decomposition point (231-33°) and iodine content (65.36 per cent.).

Summary

(i) Thyroxine can be isolated in pure crystalline condition from all specimens of desiccated thyroid, whether cattle, sheep or pig, by the baryta hydrolysis method of Harington.

(ii) Considerable difficulties were experienced in the working up of certain fractions—difficulties which were not mentioned by Harington, but which were pointed out by Kendall. On hydrolysis of desiccated thyroid with 10 per cent. and 40 per cent. baryta in succession, the total acid-insoluble (thyroxine?) iodine gets differentiated into three major fractions: Fraction B, which is obtained as the barium-insoluble fraction on hydrolysis of desiccated thyroid with 10 per cent. baryta, and Fraction C and Fraction D, which are obtained as the barium insoluble and the barium-soluble fraction respectively, when Fraction A is subjected to the second stage hydrolysis with 40 per cent. baryta. Fraction C could be readily treated for the isolation of thyroxine by the method of Harington, when the hormone was obtained in yields of about 0.07 to 0.14 per cent. of the weight of desiccated thyroid, and representing about 5 to 7 per cent. of the total iodine in the starting material. But Fraction B and Fraction D would not yield to the usual methods for the isolation of thyroxine. Almost the very same difficulties were encountered when the isolated thyroglobulin was hydrolysed with baryta.

(iii) During processing of Fraction C, two sub-fractions were obtained: Precipitate 2 and the residual solid separating from the mother liquor after separation of the two crops of sodium thyroxine, on acidification. These two fractions together with Fraction D, all of which contain acid-insoluble iodine in high concentration (30 to 40 per cent.) could probably be used pharmacologically, in the same way as 'Thyroxine Fraction,' manufactured by Messrs. Squibb and Sons, New York, by licence of the University of Minnesota²⁷.

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References

- 1 Barger, *Organic Chemistry in Biology and Medicine*, 1930.
- 2 Harington and Randall, *Quart. J. Pharm. Pharmacol.*, 1929, 2, 501.
- 3 Leland and Foster, *J. Biol. Chem.*, 1932, 95, 165.
- 4 Kendall, *Thyroxine*, 1929.
- 5 Brand and Kassel, *J. Biol. Chem.*, 1939, 131, 489.
- 6 Harington, *The Thyroid Gland*, 1932.
- 7 Grollman, *Essentials of Endocrinology*, 1941.
- 8 Brand, Kassel and Heidelberger, *J. Biol. Chem.*, 1939, 131, 11.
- 9 Ginsel, *Biochem. J.*, 1939, 33, 428.
- 10 Harington, *J. Chem. Soc.*, 1944, p. 193.
- 11 Perlman, Morton and Chaikoff, *J. Biol. Chem.*, 1941, 139, 449.
- 12 Thompson, et al., *J. Clin. Invest.*, 1937, 16, 479.
- 13 Harington and Salter, *Biochem. J.*, 1930, 24, 456.
- 14 Foster, Palmer and Leland, *J. Biol. Chem.*, 1936, 115, 467.
- 15 Baumann, *Z. Physiol. Chem.*, 1895-96, 21, 319.
- 16 Reinecke and Turner, *J. Biol. Chem.*, 1943, 149, 563.
- 17 Kendall, *J. Biol. Chem.*, 1919, 39, 125.
- 18 Harington, *Biochem. J.*, 1926, 20, 293.
- 19 Ludwig and Mutzenbecher, *Z. Physiol. Chem.*, 1939, 258, 195.
- 20 Foster, *J. Biol. Chem.*, 1929, 83, 345.
- 21 Kendall and Simonsen, *J. Biol. Chem.*, 1928, 80, 357.
- 22 Harington and Randall, *Biochem. J.*, 1929, 23, 373.
- 23 Dey, Krishnan and Giriraj, *Curr. Sci.*, 1944, 13, 199.
- 24 Dey, Krishnan and Giriraj, *Curr. Sci.*, 1944, 13, 9.
- 25 Dey, Krishnan and Giriraj, *Curr. Sci.*, 1943, 12, 272.
- 26 Corran, Pritchard and Rymill, *Quart. J. Pharm. Pharmacol.*, 1935, 8, 331.
- 27 *New and Non-official Remedies*, 1941, p. 531.

CRYSTALLINE THYROXINE FROM INDIAN CATTLE THYROID GLANDS

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IN the course of our studies on the isolation of crystalline thyroxine from Indian cattle thyroid glands, it was observed that on hydrolysis of the minced raw thyroid material by sodium hydroxide, the whole mass set to a jelly with a layer of solid fat on the top. Kendall has recorded a similar observation with some samples of American desiccated thyroid. The barium insoluble fraction was bulky and its decomposition with sodium hydroxide and sodium sulphate was unsatisfactory. A few batches of thyroid glands were extracted for the isolation of crystalline thyroxine according to the method of Kendall¹ with such modifications as were found necessary to overcome difficulties.

Experimental

The total and thyroxine iodine contents of cattle thyroid glands, freshly collected from the local slaughter house, varied from 0.83 to 0.92 per cent. and 0.35 to 0.39 per cent. respectively, on dry basis. A similar high percentage of total and thyroxine iodine was reported by Dey, *et al*² in South Indian cattle glands. Four batches of glands were separately extracted as follows:—Raw minced thyroid glands (5.84 kgm.) were heated at 95–100° C. with about 8 litres of 5 per cent. caustic soda solution in a series of hard glass jars immersed in boiling water. The fat which accumulated on the surface was removed by scraping when cold. The solution set to a jelly-like mass of fleshy colour. The mass liquefied on heating to 80° C., and it was transferred to several glass jars containing hot saturated brine. The fat and soap which accumulate at the top were again separated mechanically after cooling. The liquid set to a jelly, and on adding concentrated hydrochloric acid, the gel was broken and a brownish precipitate was thrown down. The precipitate was heated with 5 per cent. caustic soda solution on a water bath for 18 hours. Hot saturated barium hydroxide (240 gms.) solution was added and the mixture heated with constant stirring for three hours. The amount of barium hydroxide required was more than that usually recommended and this was due to the presence of large amounts of impurities which also set to a jelly on cooling. The hot solution was filtered through a Buchner funnel and acidified, while hot, with

hydrochloric acid. The crude product (151.84 gms.) which precipitated out contained 6.88 per cent. iodine. It was heated with 200 c.c. of water containing 100 gms. of barium hydroxide and a little ammonia on a water bath under reflux for 18 hours. The solution was filtered hot and the insoluble material treated with 5 per cent. caustic soda solution, heated under reflux on a water bath and filtered hot. Solid sodium sulphate was gradually added to the combined filtrates with boiling till the concentration of Na₂SO₄ reached 20 per cent. and heating continued for 6 hours. The solution was then made acid with hydrochloric acid and the precipitate formed was redissolved in 5 per cent. sodium hydroxide solution and again acidified as previously. The process was repeated till the solution was free from barium. The dry precipitate (8.85 gms.; 14.0 per cent. iodine) was dissolved in 150 parts of 95 per cent. alcohol containing a little concentrated hydrochloric acid and the black tarry resinous matter was removed by the gradual addition of small quantities of powdered caustic soda. The solution was finally made alkaline with caustic soda, and excess was removed by passing carbon dioxide through the solution. The solution on filtering was straw yellow in colour and when acidified with glacial acetic acid and heated, deposited crystalline thyroxine (160 mg., m.p. 235° C.; iodine, 65.30 per cent.).

The number and weight of raw cattle glands used in the batches for the extraction and the yield of crystalline thyroxine with its percentage of iodine, are given below.

Batch No.	Number of glands	Weight gms.	Yield of crystalline thyroxine	
			mg.	Percentage of iodine
1	1,173	5,840	160	65.30
2	929	3,260	88	65.21
3	686	3,793	109	65.13
4	784	4,028	124	65.32

The results of the experiments show that the yield of crystalline thyroxine is more or less uniform, and the average yield is 0.0028 per cent. on the raw glands.

The authors wish to record their sincere thanks to Dr. U. P. Basu for his interest in this work.

References

- 1 Kendall, *J. Biol. Chem.*, 1919, **39**, 125.
- 2 Dey, *et al*, *Curr. Sci.*, 1944, **13**, 199.

DEPILATION MIXTURES IN THE MANUFACTURE OF BOX SIDES

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Introduction

IN the manufacture of shoe upper leather such as box sides, the aim of the tanner is to produce a leather having a tight, smooth and non-cracky grain, full substance and soft and rubbery feel. All these characteristics are greatly influenced by the process of depilation. The usual practice is to depilate with a saturated solution of slaked lime to which different amounts of sodium sulphide are added to enhance the unhairing action of lime, and sometimes calcium chloride is added to reduce the swelling of the pelt. With a view to ascertain if better results could be obtained under Indian conditions from caustic soda and sodium sulphide depilating mixtures, which are reported to be used in some American tanneries, this investigation was undertaken.

Experimental

From a piece of wet salted E.I.kip, twelve small pieces measuring approximately $8" \times 3"$, were cut from as near the butt as possible and were marked 1, 2, 3, 4, 5, 6 and 11, 22, 33, 44, 55, 66. Pieces numbered 1 to 6 were cut from the right side of the back-bone line, and pieces 11 to 66 were taken from the corresponding positions on the left side.

All the pieces were soaked, washed and cleaned in water as usual.

Ten depilating baths with the following compositions were prepared:—

Series I.					
Bath No.	A	B	C	D	E
Concentration of NaOH ..	% 0.25	0.5	1.0	1.5	2.0
Concentration of Na ₂ S ..	% 0.5	1.0	2.0	3.0	4.0
Series II.					
Bath No.	F	G	H	I	J
Concentration of NaOH ..	% 0.25	0.5	1.0	1.5	2.0
Concentration of Na ₂ S ..	% 0.5	1.0	2.0	3.0	4.0
Concentration of CaCl ₂ ..	% 0.5	1.0	2.0	3.0	4.0

The temperature of the baths was 23° C. Commercial caustic soda and commercial sodium sulphide (fused) were employed.

Depilation

Series I.—Pieces 1, 2, 3, 4 and 5 were put into baths A, B, C, D and E respectively for unhairing. Piece 6 was used as a control, for comparison, and treated according to the usual trade practice. It was put into an unhairing bath containing 5 per cent. slaked lime, 2 per cent. calcium chloride and 300 per cent. water on the soaked weight of the piece.

Series II.—Pieces 11, 22, 33, 44 and 55 were put into baths F, G, H, I and J respectively for unhairing, the compositions of which differed from the corresponding baths in Series I, only in containing calcium chloride buffer in an amount equal to that of sodium sulphide. Piece 66 was the check piece in this series and was put into a bath similar in composition to that used for piece 6 in Series I.

The pieces were examined after 16 hours of immersion, and the observations led to the following conclusions:—

Series I.—(i) The hair-loosening increased with the increase in the concentration of sodium sulphide and caustic soda.

(ii) In all the pieces in Series I, the hair was sufficiently loose for unhairing in about 16 hours.

(iii) The hair was visible and not entirely dissolved in Bath A; it was reduced to pulp in Bath B, and at higher concentrations of caustic soda and sodium sulphide, as in the baths C, D and E, it was entirely dissolved.

(iv) The swelling, plumpness and *tucking* (shrinkage of area and curling of the edges) increased with increasing concentrations of caustic soda and sodium sulphide.

Series II.—The effect of calcium chloride buffer on depilation was as follows:—

(i) Calcium chloride retarded hair-loosening to some extent. Piece 11 was not ready for unhairing in 16 hours. The hair was still stiff.

(ii) Generally, all the pieces in Series II were somewhat less swollen and decidedly less plump, less hard and less *tucked* than the corresponding pieces in Series I.

(iii) The fibres of the pelt were more discernible in the cut edge than in the samples of the other series. The fibres at the cut edges of pieces in Series I were held together in a compact mass.

(iv) The buffer kept the pelt in a much softer condition.

Finished Leather

After a total immersion of 40 hours, it was possible to unhair piece 11. All the pieces were unhaired and put through the subsequent operations for the manufacture of box side leather by single bath chrome tannage.

The finished pieces of leather were then examined for their physical properties to determine the quality of leather produced. The following observations were made:

(i) The break of the grain became finer, and the non-creasing property, the tightness of the grain, the tearing strength (which was considerable in all the test pieces) and the plumpness increased, whereas the softness decreased slightly with the increase in the concentration of caustic soda in the unhairing bath.

(ii) Calcium chloride increased the softness of the leather and the smoothness of the grain and decreased, to a slight extent, the plumpness and the tearing strength of the leather.

(iii) The check pieces were the softest and kindest in handle, but weakest in tearing strength of all the pieces of Series I and II.

(iv) The decrease in the tearing strength due to lime, whether added as such to the bath or produced in the liquor from calcium chloride and caustic soda, is an important finding and deserves the notice of the trade. It is probable that depilation with caustic soda and sodium sulphide without any

calcium chloride would produce the strongest leather.

(v) All-round best results were obtained from Bath C of Series I.

Large-scale Trials

Having thus fixed a depilatory bath of optimum caustic soda and sodium sulphide concentration, the experiment was conducted on a semi-commercial scale.

Ten pieces of wet salted E.I.kips were taken and cut into sides. The right-hand sides looking towards the neck, were depilated in the bath having the composition: caustic soda, 1 per cent. and sodium sulphide, 2 per cent. on the volume of float.

As controls, the left-hand sides were depilated according to the usual trade practice using 5 per cent. slaked lime, 2 per cent. sodium sulphide, 3 per cent. calcium chloride and 300 per cent. water on the soaked weight of the hides.

In both the cases, the depilation was carried out in drums for about 24 hours. After unhairing, both the right-hand and left-hand sides were manufactured into box sides by the usual process and their characteristics compared.

The leathers produced by caustic soda and sodium sulphide depilation had a softer handle, devoid of any hard or bony feel, a finer grain-break, tighter grain, greater tearing strength, better anti-creasing property and were fuller, plumper and more resilient than the leathers produced by the usual process of liming.

It appears, therefore, that depilation with caustic soda and sodium sulphide produces better box sides than the usual lime and sodium sulphide depilation. Further large-scale experiments are being carried out to confirm the above finding.

Letters to the Editor

CHINA-CLAY FOR RUBBER WORKS

IN the fabrication of rubber, a considerable quantity of china-clay is used in the mix. It has been the experience of rubber manufacturers in India that Indian china-clays, while satisfying the manufacturers' routine specifications, were inferior to imported English clay, as judged by the physical and mechanical properties of fabricated articles.

With a view to improving the more representative of the Indian clays, and bringing them up to the level of the English clay, a study of their particle-size distribution was carried out in some detail, and based on the results of the study, two methods were developed for effecting the necessary improvement.

The particle-size distributions were determined by the "beaker method,"¹ the particle sizes being estimated by applying Stokes' law. The data thus obtained revealed marked differences between the Indian and English clays. More than 50 per cent. of the former consisted of particles above 5μ in radius, while only 15 per cent. of the total was less than 1μ . The corresponding figures for the English sample were 32 and 30 per cent. respectively. It was obvious that in order to improve the quality of the Indian clay, its coarser fraction had to be eliminated to an appreciable extent. This was accomplished by passing the clay through a laboratory type "cyclone" separator² under predetermined set of conditions. The resulting product showed considerable improvement, as can be seen from its particle-size characteristics given in Table I.

TABLE I.

Particle radius μ	English clay %	Indian clay (after treatment) %
> 10	12.5	2.3
Between 10 and 5	19.4	4.3
Between 5 and 3	16.5	11.4
Between 3 and 1	21.8	15.0
< 1	29.8	67.0

The sample of treated China-clay as prepared above, was sent to the *Dunlop Rubber Works, Calcutta*, for practical tests. The composition of the test rubber mixes was: rubber, 100; clay, 70; accelerator, 1; stearic acid, 2; and zinc oxide 5 parts. In Table II are shown the test results obtained for mixes containing untreated and treated clay in comparison with the English clay.

TABLE II.

No.	Test	Rubber mixed with Indian clay		Rubber mixed with standard English clay
		Untreated	Treated	
1	Tensile strength (kgs./sq. mm.)	1.4	1.8	1.7
2	Stretch at 0.5 kgs./sq. mm. load	340	315	290
3	Stretch at break	575	625	600
4	Permanent set after stretching at 0.5 kg./sq. mm.	24	18	22
5	Hardness on Dunlop Tester	52	52	58
6	Tear resistance in lbs./1" strip:			
	(a) tested at room temp.	85	80	65
	(b) tested at 100° C.	45	65	35

It was reported that "while the tensile strength, permanent set and tear resistance indicate superior figures to those obtained from the English clay, the percentage stretch at 0.5 kg./sq. mm., and the hardness show slight inferiority. On the whole, however, the indigenous clay treated by the air-flotation process is considered equal to the English material."

Another method for improving the clay, by using a 1 per cent. solution of sodium silicate as a peptizing agent and carrying out fractional sedimentation, was tried with satisfactory results.

The relevant details necessary for enabling the rubber manufacturers to purify the indigenous material have been supplied to them. The authors desire to acknowledge the co-operation given by the *Dunlop Rubber Co.* in supplying the Indian and foreign China-clay samples and in testing the treated product in their factory.

Physical Laboratories
Council of Scientific and
Industrial Research,
14th November 1945.

S. S. BHATNAGAR,
A. JOGARAO,
LAL C. VERMAN.

¹ R. J. Davies, R. A. Green and H. F. E. Donnelly, *Trans. Cer. Soc.*, 137, 36, 173.

² G. D. Joglekar, *J. Ind. Chem. Soc., Indust. & News Edn.*, 1942, 5, 102.

DETERMINATION OF OIL IN PARAFFIN WAX USING ULTRASONICS

BESIDES the standard method for determining expressible oil in paraffin wax scale¹, there are other methods² involving the solution of a known weight of the wax in a suitable solvent, chilling to the proper low temperature for crystallizing out the wax, filtering, evaporating the solvent and weighing the oil. The procedure suffers from the disadvantage that it is time-consuming and filtration at low temperatures involves many experimental difficulties. A refractometric method has been suggested, but it is not considered to be sufficiently accurate, particularly in the case of refined waxes. The possibility of developing some other physical method was, therefore, explored.

In recent years a number of determinations of the velocity of ultrasonic waves in different mineral oil fractions^{3,4} have been made, and it has been shown that there are

appreciable variations in the velocities. Preliminary experiments were undertaken to study the changes in the velocity of ultrasonic waves in paraffin wax mixed with varying amounts of mineral oils. A temperature of 155° F. was arbitrarily chosen for the determinations as it was a little above the minimum temperature required to give clear visibility through the molten wax.

The experimental arrangement employed was the same as that used earlier by Parthasarathy, Pande and Pancholy⁵ in these laboratories. A sample of refined Assam wax was first rendered oil-free by dissolving it in excess of methyl ethyl ketone, cooling to room temperature (90-95° F.), filtering the wax crystals, washing repeatedly with the solvent until free from oil and drying. The wax was then melted on a water bath, filtered hot and finally heated on a water bath under reduced pressure to remove the last traces of the solvent. The temperature of the molten wax was maintained constant within 0.5° F. during the experiment by means of electrically heated pads pressed

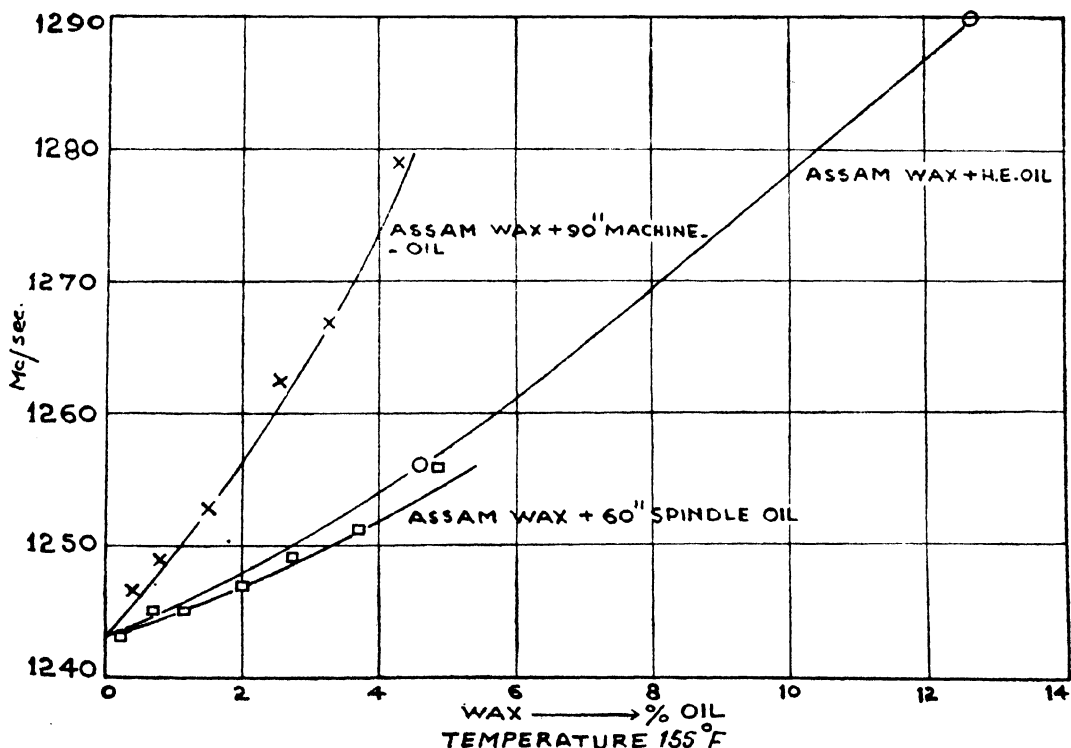


Fig 1

against the parallel plate cell. The frequency of the ultrasonic waves was maintained constant to within 0.007 Mc./s. The accuracy of velocity determination is ± 1 metre. The oils required for admixture with the wax in this study, were obtained from *Messrs. Attock Oil Co., Ltd., Rawalpindi*, and had been acid-washed and clay treated in their works. The velocities in paraffin wax with different percentages of oils (60" spindle, 90" machine oil, 180" heavy engine oil) are given in Table I.

TABLE I

Velocity in oil-free Assam wax = 1,243 metres/sec.

Wax + 60" spindle oil		Wax + 90" machine oil		Wax + 180" heavy engine oil	
Oil %	Velocity Met./Sec.	Oil %	Velocity Met./Sec.	Oil %	Velocity Met./Sec.
0.00	1,243	0.00	1,243	0.00	1,243
0.18	1,243	0.35	1,247	4.76	1,256
0.68	1,245	0.71	1,249	12.66	1,290
1.06	1,245	1.46	1,253		
2.00	1,247	2.46	1,263		
2.72	1,249	3.29	1,267		
3.64	1,251	4.30	1,279		
4.87	1,256				

The results have been graphically represented in Fig. 1. It will be noticed that mixtures of different oils and paraffin wax exhibit different velocity gradients. The relation is linear in admixture with lower percentages of oil in which we are more interested at present. It is quite likely that

the relation may not be linear when larger amounts of oil are added to the wax, as has been reported by other workers⁶⁻⁹ in case of mixtures of various organic solvents. The results show that the ultrasonic velocity determination provides a simple and elegant means for determining the percentage of oil in wax if the nature of the oil is known.

The authors are grateful to Dr. Sir Shanti Swarup Bhatnagar, F.R.S., for his guidance and to *Messrs. Attock Oil Co., Ltd., Rawalpindi*, for permission to publish these results.

Council of Scientific and
Industrial Research,
Delhi, 25th October 1945.

M. PANCHOLY.
A. PANDE.
P. SHEEL.

¹ Institution of Petroleum Technologists—*Standard Methods for testing I.P.T., Serial Designation, P.S.-43*.

² *The Science of Petroleum* (Oxford University Press) 1938, 2, 1436.

³ Williard, *J. Acous. Soc. Amer.*, 1941, 12, 438.

⁴ Parthasarathy, Pande, Pancholy, *J. Sci. Ind. Res.*, 1945, 3, 209.

⁵ Parathasarathy, Pande, Pancholy, *J. Sci. Ind. Res.*, 1944, 2, 295.

⁶ Dereuzim and Giacomini, *La Ricerca Scientifica*, 1942, 13, 242.

⁷ Ram Prasad, *Ind. Jour. Phys.*, 1942, 16, 1; 1943, 16, 307.

⁸ Wilson & Richards, *J. Phy. Chem.*, 1932, 36, 1268.

⁹ Parthasarathy, *Proc. Ind. Aca. Sci.*, 1936, 3A, 297.



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PLANNING SCIENTIFIC RESEARCH

MUCH attention has been recently devoted to the problems connected with the organization and development of science. The war brought science to the centre of the stage and spotlighted it. Through proper organization and effective application scientific research yielded spectacular results. The imperative need for cultivating science on a wide front for the promotion of health, prosperity and security of nations has come to be widely recognized. There have been many discussions at a high level both in the United States of America and in the United Kingdom, on the policies and programmes necessary for the encouragement of scientific research and development. These discussions have led to a clarification of many issues, which appeared somewhat vague in the past, and are of interest to India.

In his remarkable report, *Science—the Endless Frontier*, which Dr. Vannevar Bush presented to the President of the United States of America in July last, and which, it is understood, is to be the basis of important legislation in the United States, the need for formulating a national policy for science has been well brought out. Dr. Bush points out that the Government has only *begun* to utilize science for the promotion of national welfare. What has already been achieved is likely to be dwarfed by what can be achieved by the full and deliberate development and utilization of science.

Research and State Responsibility

Dr. Vannevar Bush has classified research activity under three broad groups—Pure,

Basic or Fundamental Research; Background Research; and Applied Research and Development. The three groups are by no means exclusive, but it is convenient to consider research under these heads. Research which is undertaken without any practical ends is classified under pure research. It results in an increase in the knowledge of the material universe, and while it does not set out to offer specific answers to practical problems, it provides the basic knowledge and technique necessary for their solution. Development of new industries is dependent on the continuous development of pure research. Those who need and who use the results of such research in education, agriculture, industry, medicine and public health, have all a special interest in its development. The beneficiaries of pure research are the people as a whole, and for this reason it is entitled to State support in the same manner as education.

Background research which includes surveys of natural resources, descriptions of basic facts and determination of standards, provides the data necessary for advances in both pure and applied research and it is essentially the responsibility of the State to provide such data. Dr. Vannevar Bush includes under background research the preparation of topographic and geological maps, collection of meteorological data, determination of physical and chemical constants, description of species of animals and plants, establishment of standards for drugs, hormones, X-ray therapy, and so on. The data are widely used by engineers,

physicists, chemists and the public at large. Background research has well defined objectives and lends itself to planned and co-ordinated work by teams of trained workers. It is clear that background research has to be undertaken primarily by the State and the results of the investigations should be made available to the public in a systematic manner.

Applied research and development are of definitely practical and commercial value and represents a field in which the public evinces keen interest. It draws freely from the knowledge revealed by basic and background research and applies it to a multitude of practical ends—new products, new industries, etc. Research which has a strictly utilitarian and commercial value is willingly and energetically undertaken by industry. There are, however, certain regions of applied research where the profit motive for undertaking research is not obvious, e.g., in agriculture and in some industries like cottage industries, in which the units are widely dispersed, and in such cases research and development are likely to suffer unless it is undertaken by Government.

It is clear, therefore, that Government has a special responsibility in the promotion of pure research, background research and certain fields of applied research and development. The State should encourage research by industry as such research leads to improvements in productive activity and, therefore, promotes the general prosperity of the nation. The State has a special responsibility also to undertake research essential for national security.

Pure Research Essential to National Welfare

War-time experience has enlarged views on scientific research. Nothing is more significant than the importance which basic or pure science has come to acquire in the general scientific structure. It must be emphasized that the striking advances made during the war, were all based on scientific knowledge acquired by patient research in many fields of inquiry before the war. The pressure of war served to accelerate development and large-scale application, and what should have taken many years in peace-time was achieved in a remarkably short period under a compelling necessity and due to Government support and overall co-ordination.

Universities and research institutions are the traditional centres of pure research and it is the responsibility of the Government to see that the vitality of these centres for the cultivation of knowledge is adequately safeguarded. In the past, these institutions received support from private philanthropy and Government. An analysis of research expenditure on various types of research in the United States of America has revealed that support for basic research from private sources is gradually, but markedly, dwindling. This appears to be the case in other countries too. Research costs by way of equipment, salaries, etc., on the other hand, are steadily mounting, and unless State support is assured on a large scale there is every danger that the development of basic research would suffer.

Both Government and industry depend on universities for the supply of basic knowledge and the research personnel required in their establishments. It becomes, therefore, the responsibility of the State to maintain these institutions in the highest level of efficiency and achievement.

Planning for Progress

It is now realized that planning and organization are essential for the promotion of scientific research. The war emergency revealed, and the scientists participating in the war effort realized, that when science is directed without a plan, as in the pre-war years, many fundamental problems do not receive adequate attention. For ensuring the development of science on an even front, some sort of planning is a prerequisite. While it is fully appreciated that freedom of mind is necessary for significant achievement, the objectives of autonomy in science and subservience to social needs are not necessarily antithetic. The lesson of Soviet Russia where all scientific activity is guided centrally by the *Academy of Sciences*, shows that science can flourish under a plan as long as the direction is derived from those who are fully alive to the needs and requirements of scientists. Originality and individuality, initiative and enthusiasm, which are the requirements of scientific progress are not necessarily jeopardised by planning. With the growing need for State support for research of all types, there is a corresponding need on the part of scientists to recognize the social needs and purposes of science.

Yet another argument in support of planned effort is provided by the impressive results obtained by team work. The work on the chemistry of penicillin illustrates the possibilities of team research and the advantages that accrue by the free and full interchange of knowledge and ideas within a co-operating group. Team work calls for planning and direction and facilitates creative enterprise by bringing together a wide assortment of qualities and skills.

To sum up, a national policy for science is necessary to ensure scientific advance on a wide front.

Government should assume responsibility for the promotion of scientific research and its utilization in the interests of society, and State funds should be made available for these purposes.

For effectively discharging this responsibility, an agency comprised of scientists should be established which will not only supervise and direct research work under Government auspices, but also assist scientific work conducted outside Government. It should interest itself not only in the advancement of scientific knowledge and

education, but it should also promote the utilization of scientific research for the benefit of the nation.

There is a wide awareness in India of the benefits which large-scale scientific development can bring. Background research has received the attention of Government for many years, and more recently research activity in this field has been strengthened. Government have also taken keen interest in the development of applied research during the past few years. The report of Prof. A. V. Hill on Scientific Research in India and the Report of the Industrial Research Planning Committee, have both emphasized the need for enlarging facilities for scientific research and development on a large scale to meet the social and economic needs of the country. A comprehensive plan for the development of scientific research on a bold and imaginative scale has not been adopted so far. India stands on the threshold of great developments, and an organization of scientists with a well defined policy and programme is urgently needed. An operative plan should be formulated *now*, and the materials, men and money required should be mobilized for giving effect to it. There is no time to be lost.

ASSISTANCE TO INDUSTRIAL DEVELOPMENT

PROPOSALS IN THE 1946-47 BUDGET

THE following among the wide variety of problems tackled by the budget are of particular importance from the point of view of the industrial development of the country.

Post-war Planning

Great strides have been made during the past twelve months in respect of development planning. Preparatory work has been expanded and intensified in many fields including essential training and various research activities. All-India policies in respect of a number of subjects such as education, food, labour, transport and civil aviation have been announced. All Provincial Govern-

ments have formulated their five-year plans which are now being co-ordinated; they are likely to be finalised in the course of the next few months. They involve an expenditure of the order of Rs. 900 crores. In addition to these, Central plans in respect of railways, roads, etc., would also add up to a considerable amount. A lump-sum provision of Rs. 35 crores has been made in the budget estimates for advance payments and of Rs. 15 crores for loans to Provinces to speed up development schemes which provide a high proportion of employment in relation to their total cost. The Provincial plans are based on the assumption that, apart from borrowing, the

Provinces will get Central grants during the first five-year period amounting to about Rs. 250 crores.

An advance stage of preparation has been reached in respect of the establishment of an **Industrial Finance Corporation** in order to ensure the availability of medium and long-term credits to industrial enterprises in India where more normal methods of industrial finance are inadequate. The Government is investigating the need for forming a **National Investment Board** for securing the fullest and most advantageous utilization of the economic resources of the country in the interests of planned capital development. Meanwhile the existing control over capital issues is to continue.

Taxation Proposals

In introducing the new taxation proposals, the Finance Member pointed out that fiscal policy should serve the requirements of national policy and should seek to raise revenue in such a way as to obtain the maximum social and economic advantage. Two facts stressed in this connection are that first, a great deal of money would be required to combat the evils of poverty, ill-health, squalor, illiteracy and unemployment, and, secondly, that during the next year or two, Government must do all it can to offset the fall in economic activity which will otherwise result from the heavy drop in military expenditure.

The fiscal problem, so far as industry is concerned, is how to lay it under a heavy contribution and at the same time to encourage it to expand. The following proposals are likely to act as a direct fillip to industrial enterprise :—

1. The *Excess Profits Tax* is to be completely removed and no tax will be payable under *E.P.T.* on profits earned after the 31st March, 1946.

2. The present income-tax and super-tax payable by joint stock companies is to be reduced from 7 annas 9 pies to 6 annas.
3. Special initial depreciation allowances of 10 per cent. on new buildings and of 20 per cent. on new plant and machinery are to be granted.
4. Expenditure on scientific research is to be allowed for income-tax purposes.
5. Raw materials imported for industry are to be given relief from customs duty.
6. Rates on such imported plant and machinery as are now dutiable are to be reduced after a careful review of the position.

Control of Dividends

Certain measures are proposed to keep the distribution of dividends within reasonable bounds and to encourage the ploughing back of profits into business. Excluding dividends payable at a fixed rate, sums equal to 5 per cent. on the capital of the company including reserves and equal to 30 per cent. of the total income may be distributed without attracting more than one-anna rate of super-tax. Dividends above that datum line will become liable to additional super-tax at steepening rates.

Encouragement of Building to Combat Deflationary Tendencies

Relief is to be granted in connection with building programmes. For residential buildings a two-years income-tax exemption is proposed. For buildings used for purposes of business, profession or vocation, the initial depreciation is to be 15 per cent. instead of 10 per cent.

SOUNDING UPPER ATMOSPHERE BY RADIOSONDE

By L. S. MATHUR

(The Observatory, New Delhi)

IN recent years revolutionary changes have taken place in the construction of meteorological instruments used for sounding the upper air. The application of electronics to the instrumental technique has opened a fresh field for the designer, resulting in the production of new types of radio-operated instruments such as radiosonde, radio-theodolite, radar, etc. Different countries have independently evolved different types of instruments for the same purpose.

During the war, the *India Meteorological Department* set up a programme of development of radiosonde in India on lines similar to those adopted in other countries. The work progressed independently at New Delhi and Poona and resulted in two different types of radiosondes. The instrument developed at New Delhi adopted the principle of Lange's¹ radiometeorograph and that at Poona employed the idea of Bureau's² radiosonde. In course of time the New Delhi instrument* was classified as "C-type" on account of the use of a clock, and the Poona one designated as "F-type" due to its being a fan-operated radiosonde. In the present account the C-type radiosonde is being described.

The radiosonde is an assembly of a meteorological unit, a transmitter and high and low tension batteries. The entire assembly is tied in a bamboo cage much in the manner as shown in Fig. 1 and carried aloft by a free hydrogen-filled balloon. The balloon when filled with hydrogen, can balance a weight of 3,500 gms. in the air. As the instrument weighs only about 800 gms., the net free-lift is enough to carry the radiosonde aloft with a rate of 18 to 20 kilometres per hour.

The radiosonde may thus be considered, so to say, as a miniature flying observatory carrying its own radio transmitter station with it. The observatory portion of the instrument passes on the data about the various meteorological elements such as pressure, temperature and humidity to the radiotransmitter, which in turn instantaneously communicates the information to the receiving ground station. At the ground

station, an electrically operated recorder automatically registers the meteorological elements in a graphical form. The observer on the ground interprets the data thus received and prepares a coded message regarding the thermal structure of the atmosphere for transmission to forecasting stations.

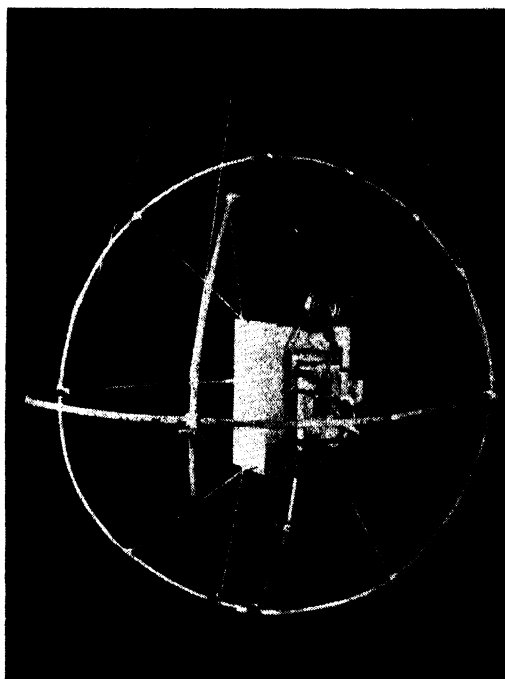


Fig. 1

For all practical purposes the graphs of pressure, temperature and humidity are continuous upto the extreme height reached by the balloon. After the ultimate bursting of the balloon when it reaches levels in which the expanded rubber fabric cannot stand the strain, the instrument falls to the ground. The rate of descent is much faster than that of the ascent, although the burst balloon itself acts somewhat like a small parachute. Sometimes a small parachute is used which comes into operation during the downward movement making the descent slower and assuring less forcible impact of the instrument on the ground.

* A technical account of this instrument is under publication as a *Scientific Note* of the *India Meteorological Department*.

Components of the Unit

The miniature observatory of the radio-sonde is shown in Fig. 2.

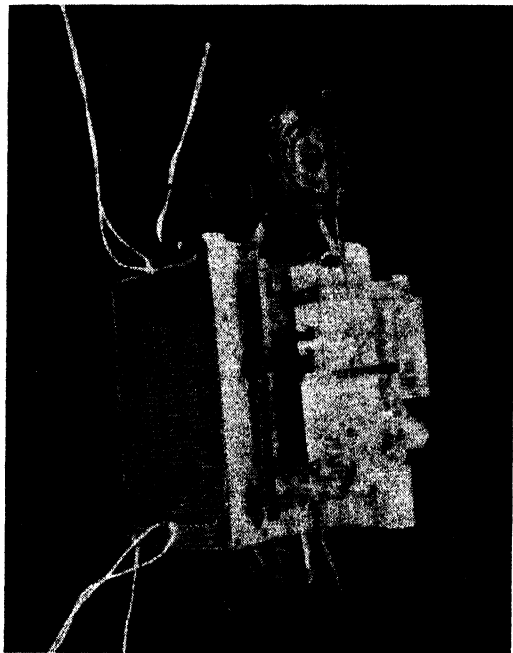


Fig. 2

This comprises an aneroid, two bimetallic dry temperature spirals, a bimetallic wet temperature spiral and a hair element. One of the dry temperature spirals has a higher magnification than the other and serves as the principal element while the second acts as a duplicate or a standby. All these components are provided with suitable pointers which move up and down, due to changes in meteorological elements. The pens rest on a small insulating cylinder about $\frac{1}{8}$ " in diameter, on which a fine conducting helix of quarter inch pitch is embedded. The cylinder is rotated by a special clockwork at the rate of two revolutions per minute. The electrical circuit of the radiotransmitter is so arranged that when any of the pens comes in contact with the helix, the plate circuit of the transmitter is closed, which makes its antenna radiate a signal for a short time depending upon the duration of contact of the pen with the conducting line on the insulating cylinder. The entire meteorograph unit, which is the observatory part of the instrument, is mounted on the lid

of a *balsa** wood box above the high tension battery assembly. This is shown complete with box in Fig. 2.

The principle of operation of the instrument can be understood by reference to Fig. 3.

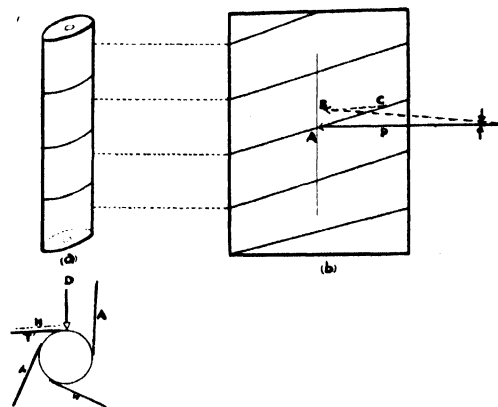


Fig. 3

The insulating cylinder is represented by (a) in Fig. 3. For purposes of explanation, we may assume that the insulating surface of the helix is cut parallel to the cylindrical axis and spread out. This is represented by (b) in Fig. 3. The relative position of various pens on the cylindrical surface are shown at (c). The pen D represents a datum pen, which does not move up or down. If the pen shown in Fig. 3(b) remains steady in the position A, it will send out a radio pulse every 30 secs. due to the rotation of the conducting helix. If, however, this pen moves up into position B due to a change in the meteorological element, it will not come in contact with the helix exactly after 30 secs. but after $30 + dt$ secs., where dt is the time taken by the helix to rotate from the position B to the position C. Similarly, when the pen moves down by an equal amount the second contact will arrive after $30 - dt$ secs. from the instant the pen arm moved from its initial position A. As the movement of the pen, up or down, is proportional to the change in the meteorological element, the time interval between successive contacts will be a measure of that change in the element.

At this stage it may be better to consider the details of construction of each component

* This is the lightest wood known.

which goes to form the meteorological observatory of the radiosonde. The aneroid element consists of two hermetically sealed small beryllium bronze capsules, interconnected to each other and provided with a small lead capillary tube. The aneroid element is exhausted several times and filled with dry air up to a pressure of 3 cm. The air left inside the aneroid is dried by passing it through a calcium chloride tower. The aneroid is finally sealed by pinching the lead capillary tube and soldering the opening. Beryllium bronze in "solutionized" state is used for producing corrugated discs with the help of a special die designed for the purpose. The corrugations correspond to a damped sine curve, with the larger amplitude towards the periphery of the disc. After punching the corrugated beryllium bronze discs, their edges are trimmed and they are tempered in an electrical furnace up to a temperature of about 320° C.

The temperature elements are made of a thin iron-invar bimetallic strip. The strip is bent into a spiral and fitted with a pointer at its free end. Each element is detachable from its brass support which is soldered to the main frame of the meteorograph unit. This has the advantage of replacing any of the elements in case it is found defective during test. The wet temperature spiral is similar to the principal dry temperature spiral, and is covered with a piece of fine muslin. The muslin is kept wet with a 30 per cent. solution of alcohol in distilled water. The liquid is stored in a circular brass container fitted above the wet temperature element. The flow of the liquid over the muslin is maintained by attaching to it a few strands of crochet cotton which are immersed in the top container. The other end of the threads is kept in a smaller container fixed to the frame below the wet element. In practice it is found that the wet temperature element, using 30 per cent. alcohol solution, gives the same readings as water wet-bulb and it is possible to obtain humidity values upto a temperature of -10° to -15° C.

In addition to the elements mentioned above, a hair-element is also provided. This consists of a few strands of degreased human hair which are linked to a thin pointer moving over the contacting helix referred to above. Changes in humidity cause variation in the length of the hair. The net effect is the movement of the attached pointer.

The values of humidity obtained from the hair element can be checked with those calculated from dry and wet temperature data.

Only two other components of the meteorological unit of the radiosonde deserve special mention. They are the contacting helix and the clock movement. The contacting helix is made in a special manner. Instead of fixing a thin wire in the form of a helix on an insulating rod, as that of ebonite, the cylindrical surface of a brass rod is scooped out by a rotary cutter of the required width leaving a fine helical metallic line of quarter inch pitch. This is done by fixing the rod on a lathe mandrel and moving the rotary cutter along the axis of the rod, the tool post being connected to the automatic longitudinal feed of the lathe. The cutter is very slowly moved along the rod by reducing the speed of the driving pulley with the help of a speed reducing gear coupled to the driving motor of the lathe. The scooped surface of the brass rod is then filled with shellac and turned so as to make the conducting metallic line reappear. These contacting helices are then mounted on the extended spindle of the clock movement attached to the main frame and housed inside a small *balsa* wood box.

The clock movement had to be specially developed for the instrument in the workshop at this observatory. In the beginning, German timepieces—*Bee* type—were dismantled and their wheels and pinions re-assembled in a straight gear train. With the progress of the war, it became increasingly difficult to obtain such clock movements from local markets. The problem of making these clock movements had, therefore, to be taken up from first principles. Suitable involute gear cutters had to be made for the fabrication of wheels and pinions, special dies were designed for escape lever and balance wheel. The entire technique of making hair springs from beryllium bronze wire was developed. To make the manufacture of clock movements as simple as possible, only two different types of wheels were employed and all the pinions were made similar. The balance wheel and the size of the hair spring are so chosen that the extended spindle of the wheel directly geared to the escape wheel rotates at 2 r.p.m. The entire clock movement is shown in Fig. 4.

This completes the description of the various components of the meteorograph unit.

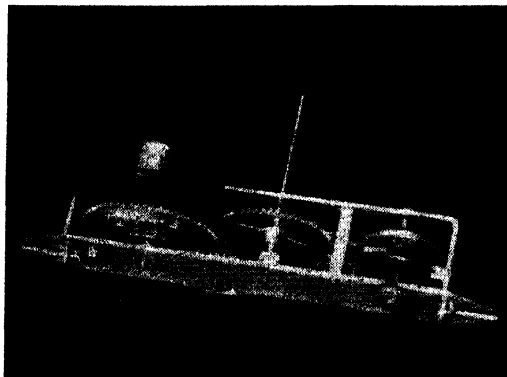


Fig. 4

The Transmitter

The radio station consists of a single tube tuned-plate tuned-grid transmitter oscillating at a frequency of 80 megacycles. The circuit diagram of the transmitter is shown in Fig. 5. It employs a double triode valve such as 1G6G. With a single triode valve such as Type 30, 1H4G and Mazda HL23 similar transmitters are also rigged up. In the case of the latter tubes, the antenna is tapped from the plate coil and consists of a copper wire 18 s.w.g. The antenna is tied up vertically with the string attached to the balloon. A photograph of the transmitter with its low-tension batteries is shown in Fig. 6. The radio tube is mounted on a cardboard piece and all connections are made on a small rectangular strip of bakelite sheet, which is attached to the cardboard. The connections are made as short as possible.

The low-tension batteries and the transmitter are housed in the same compartment of the *balsa* wood box. These low-tension batteries are of the "inert" type. The depolarizing mixture is rammed round a carbon rod in the form of a cylinder which is wrapped with blotting paper and slipped into a seamless zinc can. The cell is activated half an hour before the ascent by pouring an electrolyte into the zinc can. As mentioned before, on the opposite side of this compartment a high-tension battery is located. For some time Leclanche cells* employing small zinc containers and carbon plates pressed between square depolarizing tablets were used.

However, at present, a cup type high-tension assembly developed at Poona is

* A full account of the high-tension cells of this type is to be published shortly.

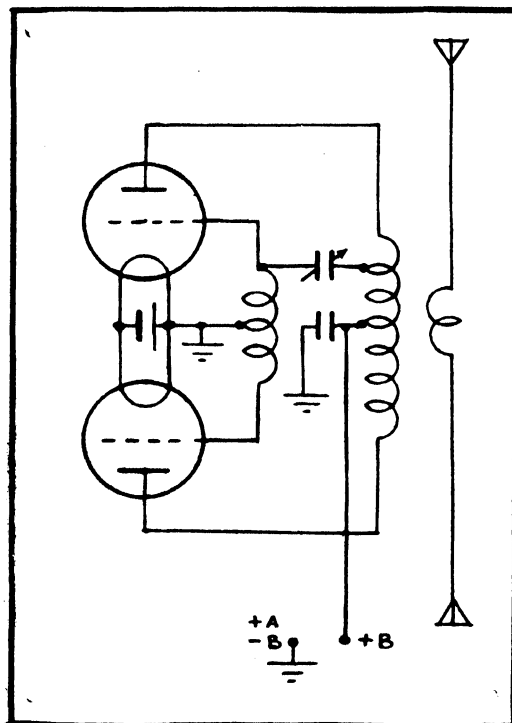


Fig. 5

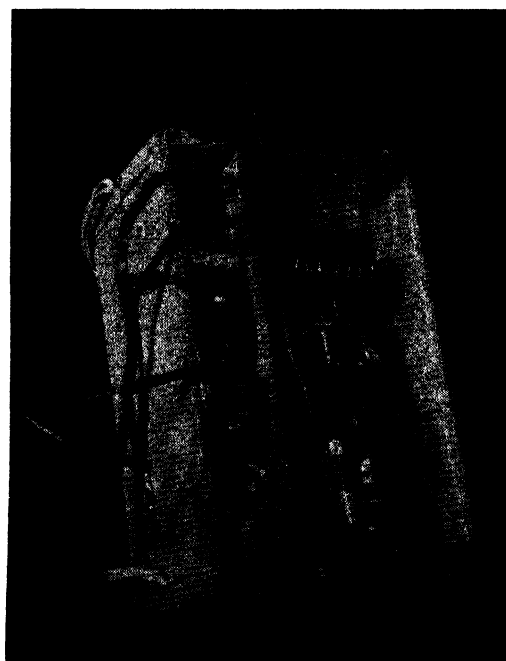


Fig. 6

being used. Each cell in this assembly consists of a carbon cup which is filled with the depolarizer mixture in the form of a paste. The cup is then covered with blotting paper disc moistened with the electrolyte (saturated solution of ammonium chloride and zinc chloride). Finally, a zinc disc equal to the diameter of the carbon cup is placed over the blotting paper disc. This is equivalent to a single Leclanche cell. Each cell is put over the other so that the carbon surface of one is in contact with the zinc disc of the other. This comprises cells in series. To get about 110 volts, 80 such cells are placed in four rows which are connected to each other by means of brass strips well pressed with the help of brass springs. The entire high-tension assembly weighs about 250 gms.

The Ground Station

The ground station, which collects upper air meteorological data, is in the form of a self-contained cabinet shown in Fig. 7. The receiving di-pole aerial is placed at an elevated spot, such as a tower, to avoid the shadowing effect of the surrounding objects. The aerial feeder cable is connected to two terminals on the top of the cabinet. On the uppermost rack of the cabinet, an ultra short wave super-regenerative receiver and another unit containing the receiver power supply and a relay are kept. These are seen on the top shelf at right and left respectively. Just below the receiver is a control panel with a small timepiece. The chronometric recorder is kept in a compartment on the right side of the control panel. The cabinet is made in two pieces to facilitate transport. When it is desired to use the equipment the lid of the bottom compartment is pulled up in the horizontal position. The recorder is then declutched and taken out of its compartment on to the table formed by the lid of the lower section of the cabinet.

One of the sides of the lower cabinet is also capable of being pulled up to form a table. One operator sits in front of the machine and attends to the tuning of the incoming radiosignal and takes measurements of the displacement of various marks from the datum mark. This will be understood from the description of the recorder given below. A second observer works on the side board and computes the data during the flight of the balloon. The entire equipment is switched on to an electrical power supply, 220 volts A.C., 50 cycles.

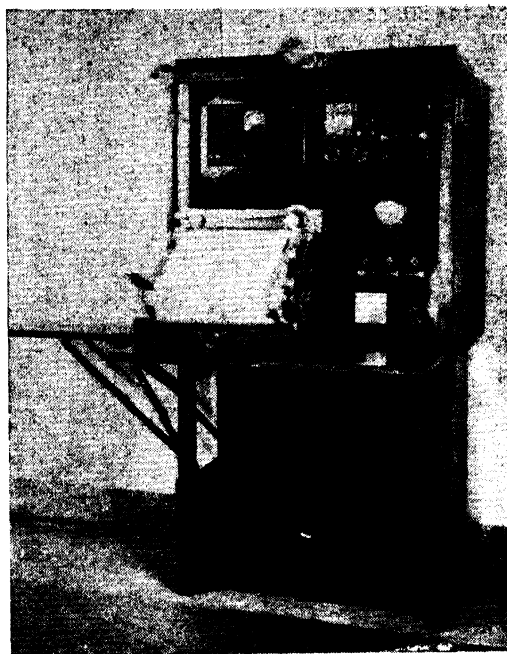


Fig. 7

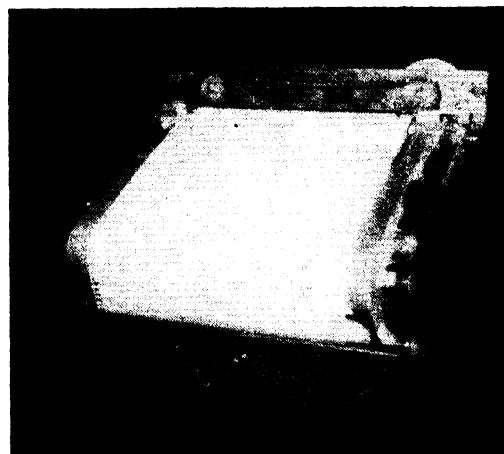
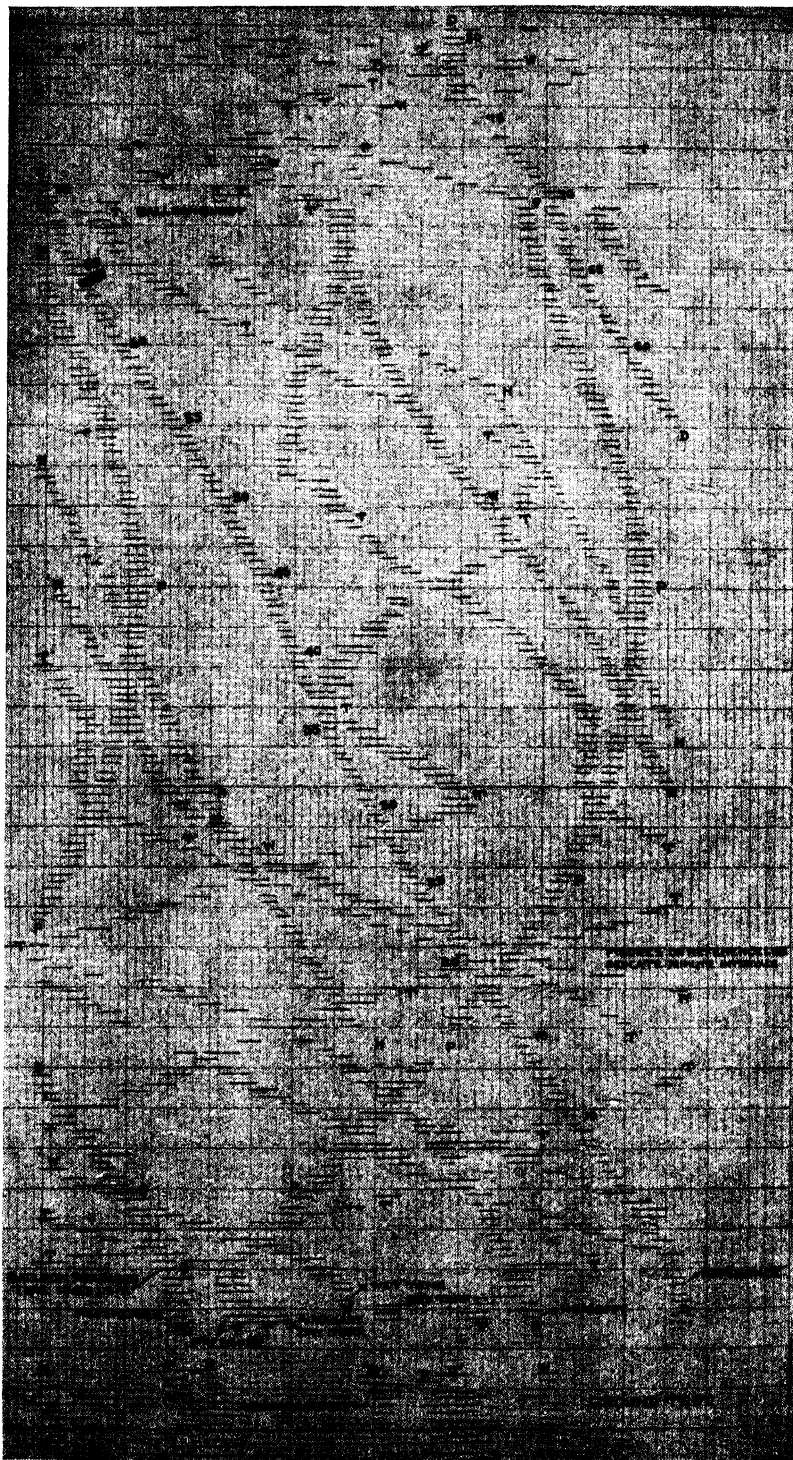


Fig. 8

The chronometric recorder incorporated in the ground equipment set-up is shown in Fig. 8. It is made in the form of a desk for facility of taking measurements during the course of the balloon ascent. An endless chain is engaged in two sprocket wheels on the top plate of the recorder. The chain is moved

6" in 30 seconds by means of a synchronous motor mounted on the back of the plate. The correct displacement of the chain is arranged by gearing the right sprocket wheel to the motor shaft through a suitable gear train. The recorder chain carries four equidistant styles 6" apart. The system is so arranged that when one of the styles is passing off the recording chart paper the other comes on the paper. The result is that one of the styles is always on the paper. The styles move over a typewriter ribbon which is held taut just above the recording chart paper. A tapper bar operates just above the styles. As soon as a signal is received by the receiver a relay mounted in the power pack is closed. This relay energizes the coils of another relay on the recorder. The coil attracts an iron piece which presses the tapper bar on the styles. The striking of the tapper bar on the styles produces a mark on the paper.

The chart paper in the recorder is moved at the rate of $1/10''$ per 30 secs. If the radio-sonde is kept under static meteorological conditions, all the pens would remain stationary and each element will send out radio signals with 30 secs. time interval between them. Due to the movement of the

**Fig. 9**

recording chart paper for each element we will get marks in straight lines parallel to the direction of feed of the paper. If due to change in a particular element, the corresponding pen gradually moves up on the contacting helix, signals from the radiosonde will give marks on the recorder which will be on a line inclined to the right. Similarly, a pen which moves down on the helix will give marks which will be on a line inclined to the left. This will be clear from the sample record shown in Fig. 9. The marks for the principal temperature, auxiliary temperature, wet bulb temperature, pressure, humidity and the reference contact are marked, T, T', W, P, H and D respectively in the figure. The principal dry temperature element has been so adjusted that decrease in temperature makes the pen go up on the contacting helix. In the sample record, therefore, the principal temperature marks have started coming to the right after the release of the balloon. On reaching the extreme right, the temperature marks (T) start again from the left and go on to the right. Each reappearance of the marks on the left is due to the pen passing over to the next complete spiral on the contacting cylinder. It will also be seen from the record that the auxiliary temperature marks are displaced to the left. This is because the bimetallic spiral makes the pen move down on the contacting helix due to the fall in temperature. This adjustment of the displacement of pens in the opposite direction helps in identifying the various marks. Of course, the record would be much simpler if some of the duplicate elements are dispensed with. The record has been obtained up to the height where the balloon actually burst. During the descent of the balloon all the marks started coming in the opposite direction. Further, as the balloon falls much faster than it rises, the inclination of the line joining the marks due to different elements is much greater after the bursting of the balloon. Normally the marks due to the fixed reference pen should lie on a straight line parallel to the direction of the feed of the paper. In the present

record, however, datum marks form a line running across the paper. This inclination of the datum line is due to the fact that the recorder motor and the radiosonde clock are not fully synchronized.

The operator on the ground measures the displacement in inches of different marks from the datum mark of a particular cycle of contacts and picks up the value of the element from its calibration graph. Each instrument is calibrated for temperature, pressure and humidity before it is sent up. The calibration is done in a special chamber which can be exhausted and also cooled to a temperature of about -50° to -60° C. by liquid carbon dioxide. The pressure is read by a single-tube manometer and the temperature with the help of a pentane thermometer. The air inside the chamber is kept well stirred by means of a fan operated by a 6-volt motor.

Acknowledgments

In the end, the author wishes to record his grateful thanks to the late Rai Bahadur Chatterjee who initiated the work under his personal guidance. It is unfortunate that he did not live to see the development and completion of the instrument. He is extremely thankful to Dr. S. K. Banerji, O.B.E., D.Sc., F.N.I., Director General of Observatories, and Sir Charles Normand, Kt., C.I.E., D.Sc., for their help and guidance in the course of the evolution of the instrument. The author is grateful to his chief, Mr. V. V. Sohoni, for kindly going through this article and for making various suggestions to improve it.

Last but not least, thanks are due to Messrs. Vidyabhushan, Gurcharan Singh, P. M. Neogy, M. K. Basu and H. Mitra of the laboratory and workshop of the observatory, who worked hard on the development of this type of radiosonde in the *India Meteorological Department*.

References

- ¹ K. O. Lange, *Bull. Amer. Met. Soc.*, May 1936,
- ² R. Bureau, *Comptes Rendus Ac. Sci. Paris*, 1929, **188**, 1565.

COAL TAR AND ITS DERIVATIVES *

PART II—BY-PRODUCT RECOVERY FROM COAL TARS IN INDIA

By C. J. FIELDER

Road Tars

THE use of coal tar in connection with construction of pavements and roads was first reported in England over a century ago, but no extensive development took place until the early part of this century when the advent of fast moving motor vehicles created a need for a dust-free and more durable type of road surface than water-bound macadam.

Early experiments made with crude coal tar and dehydrated tar were promising although not uniformly so. It was gradually appreciated that a definite degree of refining of the coal tar was essential if the best results were to be ensured. Consequently specifications for road tars were drawn up as a result of the early experiences obtained, designed to eliminate very thin and otherwise unsuitable grades of tar. These specifications were progressively improved and each country has evolved its own particular standards, although they have much in common.

The official definition of "Road Tar," according to the *British Standard Glossary of Highway Engineering Terms*, is "a product prepared by treating high temperature coal tar in such a manner that it conforms to a specification which defines its applicability for some type of surface construction."

The most important property of a road tar is its consistency or viscosity. This is determined by the viscometer which measures the time in seconds taken for a given volume of binder to flow through a standard sized orifice (10 mm.) at a given temperature. In the case of road tars the instrument chosen is a modified form of the Redwood Viscometer as approved by the *British Road Tar Association (B.R.T.A.)*. The temperature of

the test is so adjusted that the time of flow falls within the range of 10 to 140 seconds.

The grades of road tars now employed for surface treatment are of such viscosity as to need heating prior to application on the road. As a result such road tars are able to penetrate and stabilize the water-bound macadam as well as to set reasonably quickly and bond with the stone metal chippings, in contrast with the very fluid tars originally used, which were slow to set and gave rise to "bleeding" and other undesirable features.

Road tar specifications cover a wide range of viscosity and the latter is selected according to the type of surface construction for which the road tar is to be employed. The *British Standards Institution* introduced their Standard specification for road tars Nos. 1 and 2 in 1930 and this was followed by a similar specification road tar No. 3 in 1931.

These specifications are reproduced below.

Certain types of coal tars, e.g., low temperature coal tar, do not yield satisfactory road tars as are produced from high temperature coke oven tars and the above specifications are intended to exclude, as far as possible, products obtained from unsuitable sources.

In India, the Indian Stores Department specification, G/Misc-72, for coal tar for road purposes has been adopted and is based on the *B.S.S.No. 76* referred to below.

On account of the sub-tropical climatic conditions prevalent in India it has been found advantageous to employ, for certain types of road surfacing, road tars of higher viscosity than is envisaged in the specifications.

B.S.S. No. 76	Road Tar No. 1	Road Tar No. 2	Road Tar No. 3
Consistency or viscosity within the range	10-40 secs. at 30° C.	40-125 secs at 30° C.	70-120 secs. at 35° C.
Specific gravity at 15° C.	1.140-1.225	1.150-1.240	1.160-1.260
Water or ammoniacal liquor	< 0.5% by wt.	< 0.5% by wt.	< 0.5% by wt.
Other distillate (light oils) below 200° C.	< 1% by wt.	< 1% by wt.	< 1% by wt.
Distillate between 200° and 270° C.	9.5-21.0%	8.0-16.0%	6.0-12.0%
Distillate between 270°-300° C. (heavy oils)	3.5-12.0%	3.5-12.0%	3.0-8.0%
Phenols or crude tar acids	< 5.0% by vol.	< 4.0% by vol.	< 2.0% by vol.
Naphthalene	< 6.0% by wt.	< 5.0% by wt.	< 3.0% by wt.
"Free carbon"	Max. 20% by wt.	6.0-21.0% by wt.	8.0-22.0% by wt.

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor of the *Dictionary*, 20, Pusa Road, New Delhi.

An important advance in road tar specifications has been made recently by the publication of a *War Emergency British Standard Specification* No. 76 in 1943. The innovations in this latest specification are explained in the foreword thus:

"A new feature of the present *Specification* is the division of road tars into three types based not on viscosity but on road requirements. This division is related to their rates of setting on exposure, as distinct from the immediate set due to fall in temperature at the time of application which is a function of viscosity; type 'A' has the most rapid setting properties, type 'C' which is a special material and at present available in limited quantities only, is very slow setting and type 'B' occupies an intermediate position.

"It is important that road tars of types 'A', 'B' and 'C' should not be confused with road tars Nos. '1', '2' and '3' covered by the 1930 and 1931 Specifications. In the latter, the differences were merely in viscosity; all three tars were of the same type corresponding to the present type 'A'.

"To meet all requirements the viscosity range covered by the old specifications has been expanded in both directions, and this wide range makes it impossible to record all viscosities at a single test temperature. To avoid the confusion that might arise from the use of various temperatures, a new system of indicating viscosity has been introduced, namely, the *Equi-Viscous Temperature* or *E.V.T.* This is the temperature in °C. at which the tar has a time of flow of 50 seconds measured by the standard tar viscometer. Its use enables the viscosity of any road tar, whether very fluid or very viscous, to be expressed on a single scale. The value becomes progressively higher as the viscosity increases.

"Changes have been made in the schedules of requirements and it will be noticed that the permissible variations in the proportions of oils, etc., are appreciably less, and that a maximum for the total distillate has been included. The proportions of phenols and naphthalene have been reduced and an important new requirement included, namely, the softening point of the distillation residue. The latter requirement is particularly useful in excluding unsuitable road tars."

For Indian conditions the methods of construction calling for slow setting tars of the types B and C, are not normally adopted

and Type A should cover all requirements. The adoption of this new specification will, however, enable road engineers to stipulate a narrower range of viscosity for the road tars they require.

By expressing the viscosity of road tars in terms of *Equi Viscous Temperature* a comparison of all grades can be made on a single scale from the thinnest varieties down to pitch, thus avoiding the confusion of expressing the viscosities in seconds at varying temperatures.

Road tars Nos. 1, 2 and 3, etc., on the *equiviscous temperature scale* appear as follows:—

	Viscosity (B.R.T.A.)	E.V.T.
Road Tar No. 1.	10-40 secs. at 30° C.	20°—28.7° C.
Road Tar No. 2.	40-125 secs. at 30° C.	28.7°—35° C.
Road Tar No. 3.	70-120 secs. at 35° C.	37°—40° C.
High viscosity tars	..	43°—56° C.
Grouting (Tar pitch) blend	..	65° C.
Soft pitch	..	70° C.

The manufacture of road tars has been referred to under the section dealing with coal tar distillation. It is possible with some crude coal tars to distil straight to a residue which conforms to the desired road tar specification. It is preferable, however, to distil the crude coal tar to the consistency of a soft pitch and then to oil back with a selected distillate, e.g., heavy creosote from which the deleterious ingredients, i.e., naphthalene, tar acids, have been extracted. This blending must be accurately carried out in order that the viscosity range and other requirements of the specification are fully met.

Coal tar primers, road tar emulsions, tar-bitumen mixtures, fillerised and blown tars usually of a proprietary nature, have been developed to varying extents in other countries. Up to the present, however, such materials have not been employed in India on more than an experimental scale.

The production of road tar in India has increased very considerably over the last decade, as is illustrated by the following figures:—

	Production (in tons)		
1933	22,000
1934	25,000
1939	34,000
1942	46,000

These figures appear small, however, in comparison with the annual production of road tars in the U.K. and U.S.A. where it is reported to be 800,000 tons approximately in both countries.

There has been no appreciable importation of road tars into India, although considerable quantities (40,000 tons approximately) of asphaltic bitumen are imported annually for road construction.

With an extensive programme for road construction in the forefront of post-war planning in India, the consumption of road tar is likely to continue to increase as the crude tar supply position permits.

Manufacturers of Indian road tars are:

- (a) *Shalimar Tar Products, Ltd.*, Jharia.
- (b) *Bengal Chemical and Pharmaceutical Works, Ltd.*, Panihati.
- (c) *Bararee Coke Co., Ltd.*, Kusunda.
- (d) *Bombay Gas Co., Ltd.*

Coal Tar Pitch

When coal tar is submitted to distillation or evaporation and the volatile constituents are removed, the solid residual product is coal tar pitch.

The official definition of pitch, as approved by the *British Standards Institution* and the *Permanent International Association of Roads Congresses*, is as follows:—

“The black or dark brown, solid and semi-solid fusible and agglomerative residue remaining after partial evaporation or fractional distillation of tars and tar products.”

It is desirable that the derivation of the pitch be indicated, e.g., high temperature coal tar pitch, low temperature coal tar pitch.

As described in the section dealing with coal tar distillation, the residual pitch leaves the stills in the liquid state and flows *via* heat exchangers or cooler tanks to reduce the temperature to approximately 150° C. and thence the pitch is run into barrels, drums or open pitch bays where it solidifies.

Coal tar pitch is designated as soft, medium-hard or hard, according to softening point. The softening point is determined by several methods of which (i) Ring and Ball, (ii) Kraemer-Sarnow, (iii) Cube, and (iv) Float Test, are the most commonly employed.

There is no sharp line of distinction between a viscous road tar and a soft pitch, and these products overlap to some extent.

Soft pitch consists of solid or semi-solid residues with a softening point (Ring and Ball Method) below 60° C. Soft pitch is used as a base for black bituminous paints, as a felt saturant and for blending in road tars. Coal tar pitch, being very resistant to

corrosive action by water, bituminous points prepared therefrom form an excellent protective medium for iron and steel and other structural materials.

Medium Hard Pitch has a softening point (Ring and Ball) between 60° C. and 75° C. and has a wide variety of uses. It is employed in roofing mastics, damp-proof coursing, pipeline coatings, dipping solutions for castings, deck caulking and jointing compounds.

There is an Indian Stores Department Specification No. G/O.P. 66A for coal tar medium pitch of softening point range 70°-75° C.

Hard Pitch comprises pitches with a softening point (Ring and Ball) above 75° C. The principal use for this grade is for briquetting fuel, e.g., coal dust. Hard pitches are also employed in electrodes, carbon brushes, electric batteries and “clay pigeons.”

Pitch-Coke results when coal tar pitch is retorted and all volatile products are driven off. This product is utilized in metallurgical industries for special castings and electrode manufacture.

The production of coal tar pitch in India before the war amounted to approximately 2,000 tons annually.

Imports of coal tar and pitch between 1935 and 1939 averaged jointly 3,000 tons annually, mostly from the U.K. and Japan, at an average declared value of Rs. 70 per ton approximately.

Creosote Oil

This product is officially defined as “The oil or blend of oils obtained from coal tar and distilling above 200° C.”

Its production from crude tar is described under the section dealing with coal tar distillation.

Primary distillation yields a series of creosote oil fractions which may subsequently be given further treatment and blended to specification for various uses.

The lowest boiling fraction is referred to as Middle or Carbolic oil, boiling up to about 235° C. This fraction is relatively rich in tar acids and naphthalene. The latter is deposited by cooling as its solubility decreases with temperature.

The tar acids or phenols may be extracted from creosote oil by washing with caustic soda solution with which the phenols react to form soluble sodium salts—sodium phenate (or carbolate), cresylates, etc.

By adding tar acids to a middle or carbollic oil from which the naphthalene has been separated, a product known generally as (a) *cresylic creosote* is obtained which is employed in the manufacture of *coal tar disinfectants*. This creosote should have a specific gravity of as near 1.0 as possible and should contain a specified proportion of tar acids, e.g., 25 per cent. 30 per cent., etc., by volume (*vide* coal tar disinfectants).

(b) *Creosote Oil for Preservation of Timber*.—This grade of creosote oil is a wide range fraction of creosote oil boiling mostly above 235° C. which has proved itself unequalled as an effective timber preservative against the destructive influence of fungi and termites.

Creosote oil is easily absorbed into the pores of most sapwoods where it remains firmly fixed and renders the wood markedly durable. Creosote treatment is most effectively given under pressure in specially designed plant which ensures overall penetration. Suitable timber thus treated is employed for railway sleepers, telegraph poles, fencing, bridging, marine piling, etc., and will remain in sound condition for many years.

The *British Standards Institution* have issued a British Standard Specification No. 144, 1936 for "Coal Tar Creosote for the Preservation of Timber." On this specification is based the Indian Stores Department Specification G/O.P. 33C for creosote oil.

Brush treatment of timber with creosote oil is much less effective owing to inadequate penetration, but for this purpose higher boiling or heavy creosote oil fractions are to be preferred. These fractions are termed:—

(c) "*Anthracene Oil*" or "green oil," which has a specific gravity of over 1.08 and boils mostly above 270° C. Anthracene oil must be strained free from solid crude anthracene after distillation before it is suitable for use as a wood preservative.

Timber treating plants in India are installed at Dhilwan (N.W.Rly.), Naharkatiya (Bengal and Assam Rly.), Bhadravati (Mysore), and Raipur (B.N.Railway). For railway sleeper treatment these plants commonly employ a mixture of creosote and petroleum oil (60:40).

Consumption of creosote in India for wood preservation was approximately 1,500 tons annually prior to 1939, which was mainly consumed in the treatment of railway sleepers.

Considerably increased offtake for creosote oil has resulted in connection with war-time demands for temporary hutments, etc., and in consequence the production of creosote oil in India in 1942 rose to 3,500 tons from which figure it has subsequently declined somewhat due to the reduced quantity of coal tar available for distillation.

Creosote demands in India are met almost entirely from indigenous production.

The consumption of creosote for timber preservation in the U.S.A. is approximately one million tons annually. There appears to be scope, therefore, for a considerable increase in the amount of wood preservation in India when treating plants become available.

(d) A further grade of creosote is manufactured as an *Absorption of Scrubbing Oil for Benzole Recovery*. This is a middle creosote boiling mainly between 230°-300° C. with less than 8 per cent. of solid constituents present.

This grade creosote oil is covered by the Indian Stores Specification G/Misc. 93-1941. The consumption of this grade of oil in India is not large as under tropical conditions, gas or straw oil of petroleum origin, is found to be more efficient as an absorption oil.

This grade of creosote oil is also employed in the preparation of bitumen emulsions and cut backs by reason of its low surface tension and good wetting qualities. For the same reason it is employed in certain ore separation and flotation processes.

Other uses for creosote oil which have not so far assumed any significance in India are in the preparation of sheep dips and oil washes for fruit trees, as a fuel for heating and as a Diesel fuel for internal combustion engines.

Coal Tar Phenols or Tar Acids

"The mixture of those constituents of coal tar or of coal tar fractions which are soluble in aqueous caustic soda solution. The mixture consists essentially, but not always entirely, of monohydric phenols."

The chief members of this group of compounds are phenol (carbollic acid), cresylic acids (*ortho*, *meta* and *para* cresols) and the xlenols.

As is indicated in the above definition, these tar acids are extracted from the middle or carbollic oil, light oil and other creosote distillates of coal tar by washing with an aqueous solution of caustic soda.

Washing of the oils is carried out with 10 per cent. caustic soda solution in a paddle agitated mixer. On standing, two layers separate, the aqueous layer containing the sodium salts of the tar acids in solution. Caustic soda shows a preferential affinity for phenol as compared with the cresols and heavier tar acids and advantage may be taken of this fact to neutralize the tar acids in stages, the first extracts being comparatively stronger in sodium phenate and the latter extracts stronger in sodium cresylates. Thus a certain degree of separation can be achieved during the extraction process.

Crude benzole obtained by the absorption of coke oven and coal gas contains small quantities of phenols which are removed by washing with caustic soda during the refining procedure.

The tar acids are liberated from the caustic soda extract by reaction with mineral acids. For this purpose dilute sulphuric acid or CO_2 gas is employed, resulting in the formation of a separate layer of tar acids from the aqueous solution of the resulting sodium sulphate or sodium carbonate.

The carbon dioxide method has advantages in that the sodium carbonate formed can be re-causticised and utilized again in the process.

The tar acids thus obtained are then subjected to a series of distillations and fractionations to resolve them into phenol, cresols and higher boiling tar acids.

In the case of Indian coke oven tars, the percentage yields of tar acids are comparatively low. In the U.K. and U.S.A., the crude tar acid content for such tars is reported as 4.5 per cent. by volume of which 0.7 per cent. is phenol, 1.5 per cent. cresols and xylenols and the balance higher boiling tar acids and tar acid pitch. In the case of the higher temperature Indian coke oven tars, the crude tar acid content is from 1.0 per cent. to 1.8 per cent. only, of which the phenol content averages 0.12 per cent. and the cresol content 0.25 per cent. For the coke oven tars produced in small quantity at lower temperatures, crude tar acids are reported higher at 3.5 per cent. by volume of which 0.4 per cent. is phenol and 0.9 per cent. are cresols.

Under pre-war conditions extraction of the tar acids in a refined form from Indian coal tars was scarcely economical in view of competition with the imported products,

but since the war, phenol and cresylic acid have been produced in India to meet indigenous requirements.

The potential annual recovery of refined tar acid from 90,000 tons of Indian crude tars is estimated as

Phenol	.. .. .	140 tons
Cresols	.. .. .	310 „
Higher boiling tar acids	.. .. .	370 „

Bearing in mind probable post-war developments, these yields appear quite inadequate to meet future demands and if allowance is made for the reduced tonnage of crude tar normally made available for distillation, it is estimated that not more than half the potential yields given above are likely to be recoverable on an economic basis.

It is likely, therefore, that recourse will have to be made to synthetic production of phenol from benzene.

Pre-war imports of carbolic acid into India averaged 35 tons annually at a declared value of Rs. 50 per cwt.

Phenol.—Pure phenol, which melts at 41°C . and boils at 181.7°C . is the parent member of the series of compounds known as tar acids. It is soluble in water to the extent of 1 part in 13, and it first received prominence as an antiseptic under the name of carbolic acid when its important property as a bactericide was discovered by Lister. Although it is still used as an antiseptic, it has the serious disadvantage of being a strong poison and very caustic to the skin, and for this reason it has been to a large extent replaced as an antiseptic by the cresols and the higher boiling phenols.

It is manufactured as described above by careful refractionation and crystallization of the tar acid extracts obtained from coal tar distillates.

In the semi-refined state it is known as carbolic acid 60's which indicates that its melting point is not less than 60°F . (i.e., 15°C .) and that it contains a certain proportion of water and cresols—*vide British Standard Specification No. 515 of 1938*. For pure phenol there are specifications *B.P.* and *B.S.S.* No. 523 of 1938.

Phenol is utilized in the synthesis of a number of antiseptics, drugs and dyes. Nitration yields picric acid (trinitro phenol), also an explosive. Syntheses are mostly carried out *via* the mononitro phenols and sulphonic acids to yield such products as phenacetin, adrenaline, etc. Carbonation of

phenol produces salicylic acid and with phthalic anhydride, phenolphthalein is formed. Phenol is employed in the manufacture of wetting agents and detergents (cyclohexanol), artificial tannin and synthetic perfumes. Photographic developers, such as metol and quinol, as well as a number of sensitizers, are also derived from phenol.

Phenol is used in certain industrial processes as a selective solvent.

Penta-chlorophenol is a wood preservative for which a very great degree of toxicity is claimed and the use of which has received much attention in the U.S.A.

A very large industrial demand, however, has arisen in recent years in connection with the manufacture of phenol formaldehyde (Bakelite) resins. The use of these resins for plastic mouldings, varnishes and adhesives has become so extensive that the supply of phenol from coal tar has been quite inadequate to meet the demand. The normal supply has, therefore, had to be supplemented on a big scale by the synthetic production of phenol from benzene.

There are three methods of synthesizing phenol now well developed industrially. The first method consists of sulphonating benzene to form sodium benzene sulphonate, fusing this compound with caustic soda to form sodium phenate and then releasing the phenol with mineral acids. This process involves the use of 4.3 lbs. of chemicals per lb. of phenol and for this reason it has been superseded in the U.S.A. by more economic methods involving the hydrolysis of chlorobenzene.

In the Dow process, the chlorobenzene is hydrolysed at high pressure (3,000 lbs. per sq. in.) and at 320° C. with an aqueous solution of sodium carbonate in the presence of a copper catalyst.

More recently the Raschig process has been developed for which a number of advantages are claimed. In this process benzene is treated with hydrochloric acid in presence of air and a catalyst by the Deacon process. In the second stage hydrolysis of the chlorobenzene is effected by steam at high temperature in the presence of suitable catalysts. Hydrochloric acid is evolved in the second stage and is recovered and returned to the first stage of the process. The only losses are a small percentage of hydrochloric acid and the production of some diphenyl oxide and polychlorobenzenes.

In view of the small quantities of phenol recoverable from Indian coal tars and the availability of benzene, the synthetic production of phenol by one of the above methods in India would appear to present favourable prospects.

It is estimated that approximately 75 per cent. of the world production of phenol at the present time is manufactured synthetically.

Cresylic Acid or Cresols.—All the three isomeric cresols (*ortho*, *meta* and *para*) occur in the tar acids derived from coal tar. Like phenol the cresols have valuable bactericidal properties, but they have the advantage of being much less toxic. As they are only very slightly soluble in water (1 part in 50) they have to be emulsified or to be rendered effective. In this form they are known as lysol which is widely used as a surgical antiseptic (see "Disinfectants"). For the preparation of lysol the cresylic acid should comply with the *British Pharmacopoeia's* specification ("Cresol B.P.") which excludes the lower boiling *ortho* cresol.

Cresylic acid (tricresol) is employed in germicidal soaps, as a preservative in leather, glues and adhesives and in certain applications as a wetting agent and as a selective solvent. The Duo-Sol process for the production of high grade lubricating oil, which is operating at an Indian refinery, employs a mixture of phenol and cresol in conjunction with liquid propane for the solvent extraction of waxes and asphalts.

Ortho cresol, when converted to tricresyl phosphate is widely used as a plasticizer.

The mixed cresols are employed as an anti-oxidant or gum inhibitor in motor fuels.

The cresols are also employed in the manufacture of certain dyestuff intermediates, perfumes and formaldehyde resins, but for this latter purpose the *meta*-cresol is preferred due to the more rapid setting of the resins it produces.

The plastics control specification includes three grades of cresols:—

	Grade 1	Grade 2	Grade 3
<i>Meta</i> cresol	40.42	49.51	52.53
<i>Ortho</i>	10.15	6.80	6.80

the value of the grade increasing with *meta*-cresol content.

Other specifications for cresols are as follows:—

- BSS 517—1938 Cresylic acid of high *ortho* cresol
- 521—1938 Cresylic acid of 50/55 per cent. *meta* cresol content.
- 522—1938 *Ortho*, *meta* and *para* cresols.
- 524—1938 Refined cresylic acid.

Coal Tar Antiseptics and Disinfectants

Antiseptics are employed for destroying pathogenic organisms in contact with the human body.

Disinfectants are employed to destroy pathogenic organisms on inanimate matter and thereby combat epidemics of infectious diseases.

This distinction, however, is not a sharp one and certain preparations are loosely described as both antiseptics and disinfectants.

The first substance used as an antiseptic was phenol (carbolic acid). It is soluble in water, poisonous and corrosive to the flesh, for which reason it has since given place of importance to cresylic acid and the higher boiling tar acids which are progressively less toxic and irritant to the skin.

Phenol still remains the standard reference for bactericidal efficiency for antiseptics and disinfectants, as determined by the *Rideal Walker Test* (vide British Standard Specification No. 541—1934).

By application of this test the Rideal Walker (R.W.) coefficient of an antiseptic or disinfectant is obtained which represents the dilution required to render it equally effective as phenol in destroying a particular strain of *B. Typhosus*.

This test has been subjected to much criticism on various counts, but it still survives and, although modifications have been adopted from time to time, no other test has yet appeared to displace it.

The Rideal Walker Test is criticized on two main points, (1) *B. Typhosus* does not give results typical of other common pathogenic organisms, (2) the test is carried out *in vitro* in the absence of organic matter, i.e., under conditions completely favourable to the disinfectant or antiseptic.

These points should be borne in mind when interpreting results of the test. In the U.S.A. certain modifications of the test have been adopted according to *F.D.A.* technique (*Foods and Drug Administration*) to overcome these objections (vide U.S. Department of Agriculture, Circular No. 198 December 1931).

The bactericidal efficiency depends on the concentration of the antiseptic or disinfectant. For general disinfection a phenol solution of 1 in 20 parts of water is considered adequate. To determine the correct dilution of a disinfectant for the same purpose, multiply the R.W. coefficient by

20, e.g., for a disinfectant of R.W. coefficient 12 use a dilution of 1 in 240.

In the case of *antiseptics* the most widely used product is known as *lysol* (originally a German trade name) for which there is a specification in the *Brit. Pharmacopœia*—Liquor Cresolis Saponatus or Saponified Cresol. This antiseptic consists of 50 per cent. cresols (*meta* and *para*), complying with the specification for Cresol B.P. dissolved in a vegetable oil soap, forming an amber coloured clear liquid which on addition to water yields a slightly turbid emulsion.

Owing to the comparatively low solubility of cresols and higher boiling tar acids in water, it is essential first to "saponify" them to render them active bactericidally by producing a highly dispersed emulsion in water.

Lysol B.P. has R.W. coefficient of about 2.5 and is widely used as a surgical and household antiseptic.

As a general antiseptic, however, the Dettol type has recently found much favour. The active principle in this type of antiseptic is a chlorinated xylenol (*parachlor meta*-xylenol). The xylenols themselves have a germicidal value about five times that of phenol, but when a chlorine atom is introduced, as in the above compound, this germicidal value is increased ten times, and at the same time the product becomes less toxic and irritant to the skin. The Dettol type of antiseptic, therefore, only contains about 5 per cent. of the active tar acid principle which is dissolved in a vegetable oil soap and an essential oil of pleasant odour, diluted with water.

One important attribute of a good antiseptic or disinfectant is that it will retain its potency under the conditions it has to be employed in practice. It is in this respect that a number of chemical compounds which are highly germicidal under laboratory test are rendered ineffective in the presence of serum and organic matter. In this respect, saponified cresols and tar acids are particularly effective in comparison with the oxidizing inorganic type of disinfectant, e.g., potassium permanganate, sodium hypochlorite, mercuric chloride.

Coal Tar Disinfectants enjoy a wide popularity for general disinfecting purposes, i.e., for drains, latrines, floors, stables, etc. There are two types:—

Black Fluids and White Fluids.—*Black Fluids* are the more commonly used and are prepared on the same principle as lysol, the cresols being replaced by cresylic creosote, with or without the addition of high boiling tar acids. Creolin and Jeyes Fluid are two of the earliest known disinfectants of this type. For saponification, rosin, castor oil and linseed oil soaps are most commonly employed and the disinfectant is black and similar in appearance to the creosote incorporated. The composition of a typical black fluid disinfectant is:—

	Per cent. by weight
Cresylic creosote (35 per cent. tar acids)	55
Rosin soap	30
Water	15

On addition to water a white opaque stable emulsion of the black fluid is formed. The germicidal value of such disinfectants depends principally on the exact nature of creosote employed. Low grade disinfectants are manufactured from cresylic creosote containing 20 per cent. to 40 per cent. of tar acids. Such disinfectants may have a R.W. coefficient of 0.5 up to 3.0. For the better grade fluids with coefficients of 5/6, 10/12 and 18/20 increasing amounts of selected high boiling tar acids, boiling mostly between 220° and 250° C. are incorporated.

In most countries regulations are enforced prohibiting the sale of disinfectants which do not comply with certain standards, but in the U.K. and India no such legislation has been enacted and a considerable quantity of spurious and useless material finds its way on to the markets which the general public have little chance of detecting, and will accept if it possesses the smell of creosote and emulsifies with water. Black fluids are effective in soft and fairly hard water and in soap solutions, but not in salt water or urine.

White Fluids contain a comparatively high percentage of high boiling tar acids with or without the addition of cresylic creosote. These are emulsified with a small quantity of an emulsifying agent of low surface tension (e.g., Turkey red oil) and a stabilizer (gelatin, casein, etc.) and are processed to a high degree of dispersion usually through a colloid mill. "Izal" is one of the best known disinfectant fluids in this class.

The composition of a typical white fluid is:—

	Per cent.
High boiling tar acids ..	40
Turkey red oil	5
Gelatin	2
Water	53

White fluids are produced to the same R.W. coefficient values as black fluids but they have the special advantage of emulsifying in sea water and urine. White fluids are not, however, so stable in storage and are liable to "creaming" due to a difference in specific gravity of the emulsion phases.

Disinfectant Powders are sometimes employed in place of fluids. These consist of 10-20 per cent. of tar acids, usually phenol or cresylic acid, absorbed in a medium of inert powder, e.g., kieselguhr, lime, chalk, etc.

Acriflavine is a general antiseptic and disinfectant which has become increasingly widely adopted in recent years. It is a derivative of acridine, itself present in coal tar in small percentages. It is, however, synthesized in practice from dinitrobenzene.

The pre-war import of disinfectants into India was 2 lakhs gallons at a declared average value of Rs. 2-8 per gallon.

The present manufacture of good grade disinfectants in India is estimated at 3 lakhs gallons annually.

Naphthalene, $C_{10}H_8$

This hydrocarbon constitutes one of the more important by-products of high temperature coal tars. It is a white crystalline solid with a melting point of 80.2° C. and a boiling point of 218° C. It is a volatile substance and slowly vaporizes from the solid state at ordinary temperatures.

During the refining of coal tar, naphthalene distils over with the middle or carbolic oil fraction boiling between 180° C. and 230° C. as described in the section dealing with coal tar distillation.

When this fraction of creosote is permitted to settle and cool, the naphthalene salts out in a crude form from which the oil can be drained off. Refrigeration of the oil yields a further deposit of naphthalene. The presence of tar acids in the creosote appreciably increases the solubility of the naphthalene, and their removal facilitates naphthalene deposition. Efficient separation of crude naphthalene in hot climates such as India presents certain seasonal difficulties.

Crude naphthalene of a purer variety is also extracted from coke oven and gas works gas by scrubbing and absorption processes.

To refine crude naphthalene, all traces of oil must first be removed, and this is achieved by whizzing in centrifuges and hot pressing in a steam heated hydraulic press. It is then the usual practice to melt the naphthalene and wash it hot with strong sulphuric acid followed by caustic soda and water washing. Final redistillation will then yield a saleable refined product of melting point $79.5^{\circ}\text{--}80^{\circ}\text{C}$. Refined naphthalene is sold as a crystalline powder, in ball form or in flakes, obtained by subliming the refined powder.

The main use for naphthalene hitherto has been as an insecticide and a moth repellent for the preservation of clothes and fabrics. For this purpose it is mostly used in the form of naphthalene balls, but to be effective the naphthalene should be enclosed in airtight containers at the rate of 1 lb. per 100 cu. ft. of enclosed space.

Naphthalene flakes are employed for preserving skins and hides.

In the past naphthalene has often been produced in excess of world market requirements, when it has found use as a fire lighter.

Recent developments in the chemical industry in Europe and the U.S.A., however, have resulted in a large demand for naphthalene and it is at present reported to be in short supply.

By nitration and sulphonation with strong acids, nitro-naphthalenes and naphthalene sulphonic acids are produced from which the corresponding naphthylamines and naphthols are formed. These compounds are valuable dyestuff intermediates and are utilized in the manufacture of a great number of important dyes.

Chlorination in the presence of suitable catalysts yields chlorinated naphthalenes which are high melting point waxes, of the Seekay and Halowax varieties, which possess valuable insulating and wood preserving qualities.

The hydronaphthalenes (Tetralin and Decalin) are employed as commercial solvents.

By far the largest demand, however, which has lately developed for naphthalene is for catalytic oxidation to phthalic anhydride. Of the large quantity of naphthalene now available in the U.S.A. (70,000 tons) it is estimated that half is consumed in the

phthalic anhydride process. From phthalic anhydride can be synthesized benzoic acid and anthraquinone but the greatest use of this compound is now in the manufacture of alkyd (Glyptal) resins which form high class synthetic varnishes. The phthalic esters (e.g., Dimethyl, Diethyl or Dibutyl phthalates) have also assumed much importance as plasticisers and the dimethyl ester has also proved an important insecticide and mosquito repellent.

The naphthalene content of crude tars varies from 1 per cent. to 10 per cent. and is found to increase with the coking temperature at which the crude tar is formed.

Indian high temperature coke oven tars yield an average of 4 per cent. naphthalene and the potential output from Indian coal tars from 90,000 tons of crude tar is, therefore, 3,600 tons per annum. Allowing for the reduced tonnage of crude tar normally available for refining, it is doubtful whether more than 2,000 tons of refined naphthalene could be recovered economically under Indian climatic conditions. Present manufacture of refined naphthalene by Indian coal tar distillers with the restricted quantities of crude tar now available amounts to 600 tons per annum, most of which is produced in the form of naphthalene balls for moth-proofing of clothes.

Refined naphthalene was imported into India before the war from Europe and Japan. The average quantity imported annually was 500 tons at a declared average value of Rs. 15 per cwt.

Anthracene, $\text{C}_{14}\text{H}_{10}$

Anthracene is another coal tar hydrocarbon of considerable commercial importance, constituting a basic chemical extensively used in the modern dyestuffs industry. Pure anthracene crystallizes in fluorescent plates with a melting point of 216°C . and boiling point of 351°C . It is derived in a crude form from heavy creosote distillates boiling over 270°C . (Anthracene Oil) from which it separates on cooling as a greenish paste (*vide*, section on coal tar distillation).

Crude anthracene in this form contains only 15 to 20 per cent. pure anthracene, mixed with two other hydrocarbons of similar physical properties, phenanthrene, an isomer of anthracene and carbazole, $\text{C}_{12}\text{H}_9\text{N}$.

Separation of these constituents of crude anthracene is usually carried out, after the paste has been freed of oil by whizzing and

pressing, by solvent extraction with other coal tar fractions. Treatment with solvent naphtha yields a semi-refined anthracene of approximately 45 per cent. pure anthracene content. This product consists primarily of anthracene and carbazole in equal proportions and further purification can be achieved by treatment with pyridine base solvents up to a purity of 90-95 per cent.

Carbazole, which is also a basic chemical utilized by the dyestuffs industry, although of minor importance compared with anthracene, is recoverable from the pyridine base solvent in the course of the anthracene refining.

Anthracene on oxidation forms anthraquinone from which are derived a large series of vat dyes which have been highly developed in recent years. Anthraquinone may also be synthesized from phthalic anhydride and benzene.

Alizarin (di-hydroxy-anthraquinone) is the parent substance of the important alizarin group of mordant dyes, of which Turkey Red is an example.

Refined anthracene is not at present manufactured from coal tar in India but research reveals that at such time as dye-stuff industry is set up, this important chemical can be made available in suitable form from indigenous sources.

It is present in coal tar to the extent of 0.5 per cent. approx. and the potential production from 90,000 tons of crude tar is, therefore, 450 tons per annum. Under actual conditions, economic recovery of anthracene from Indian crude tars is not likely to exceed 200 tons annually.

The production of carbazole from Indian coal tar corresponds to a similar figure as that for anthracene.

Pyridine, C_5H_5N

Pyridine is the parent substance of the tar bases which are extracted from coal tar distillates by washing with dilute mineral acid.

Pyridine is a liquid boiling at $116^\circ C$. possessing a pungent and unpleasant smell, but in the presence of tar acids it forms loosely bonded salts boiling up to $180^\circ C$. It is a strong tertiary base and forms crystalline salts with mineral acids.

As extracted from crude benzole, light oil and other coal tar distillates, the tar bases are obtained as a mixture boiling over a wide range, from $116^\circ C$. up to $250^\circ C$. These distillates, after extraction of the tar

acids, are agitated with sulphuric acid. On standing, a separate pyridine acid layer settles out. This is diluted with water and then neutralized with lime or caustic soda and steam distilled. The pyridine bases distil over and form a separate layer on the addition of caustic soda solution in which they are insoluble.

The crude pyridines, after dehydration, are fractionally distilled to specified boiling point range.

Refined pyridine bases are marketed commercially in two standard grades—(1) 90 per cent. boiling below $140^\circ C$., (2) 95 per cent. boiling below $160^\circ C$. These contain a mixture of pyridine with the picolines, lutidines and collidines and higher homologues.

Although used on a small scale in the manufacture of dyes and pharmaceuticals, the main uses of pyridine have hitherto been as a denaturant for methylated spirits and as an industrial solvent.

Tar bases are present in coke oven tars to the extent of 2-3 per cent. of which pyridine itself does not exceed 10 per cent. Commercial pyridine is only produced in India on a very small scale from gas works coal tar distillates.

Tar bases derived from Indian coke oven crude tar, have a boiling point range of $150^\circ C$. upwards.

Benzene, C_6H_6

Benzene is the simplest member of the aromatic series of hydrocarbons. It is a liquid with a boiling point of $80.2^\circ C$. and melting point $5.5^\circ C$. and is mainly derived by extraction from coke oven and gas works gas. The methods employed to extract and refine benzene are described in the section "By-products from coke oven gas." A comparatively small quantity of benzene may also be derived from the light oils distilled from coal tars, which boil below $170^\circ C$.

It is first obtained in the form of crude benzole, consisting chiefly of benzene, toluene and the higher aromatics, and described as 50/90's, indicating 50 per cent. by volume distilling at $100^\circ C$. and 90 per cent. at $120^\circ C$.

Further fractionation and refining is then provided to separate benzene in the pure form to produce *Motor Benzole*, a mixture of benzene, toluene and xylenes.

A very large proportion (probably 80 per cent.) of the benzene extracted in the

coking industry is absorbed in motor benzole, which, mixed with certain proportions of petrol, forms a high quality motor fuel. The distillation range for motor benzole is specified as

not less than 60 per cent. at 100° C.

„ „ „ 85 „ „ „ 120° „

„ „ „ 95 „ „ „ 145° „

It must also conform to colour, oxidation and maximum sulphur tests.

The following commercial grades of benzole are also standardized under specification issued by the *National Benzole Association*, and adopted by the *British Standards Institution* in B.S.S. No. 135-1939:—

- (1) 90's Benzole—90 per cent.—95 per cent. boiling at 100° C. 97 per cent. boiling at 115° C. (minimum).
- (2) *Industrial Benzole* of similar distillation range to motor benzole but free from unsaturates.
- (3) *Pure Benzole* must distil from 5 per cent. to 95 per cent. within a range of 0.5° C.
- (4) *Pure Benzole for nitration* from 5 per cent. to 97 per cent. must distil within a range of 0.4° C. (between 79.5° and 80.5° C.)

The industrial uses of benzene are very extensive. Conversion of pure benzene by nitration, sulphonation and chlorination yields nitro-benzenes, benzene sulphonic acids and chlorobenzenes respectively. From the former aniline and benzidine are manufactured and from the two latter phenol can be synthesized. From these compounds are derived a very large number of dyestuff intermediates and they are also of much importance in the fine chemical industry in the manufacture of pharmaceuticals, drugs, photographic chemicals, etc.

From benzene can be synthesized such important chemicals as vanillin, resorcinol, acriflavin, mepacrin and sulphonamide group of drugs. *P-dichloro benzene* is an important insecticide and from benzene is also derived the recently discovered and more famous DDT.

As a solvent, benzene is very widely used in industry in the production of paints, varnishes, lacquers, polishes and leather dressings, rubber and waterproofing solutions, cleaning and degreasing agents and adhesives and plastics.

The production of benzene in India has up to the present been almost entirely confined to motor benzole. A recent develop-

ment is the catalytic alkylation of benzene with propylene, obtained from petroleum refinery gases, to form cumene (isopropyl benzene), a hydrocarbon of very high octane rating, which is blended into high performance aviation petrol.

It is anticipated, however, that with the development of chemical and dyestuffs industries in India in the post-war period the demand for pure benzene and industrial benzoles will increase.

The potential output of benzene in India with existing plant is 22 lakhs gallons annually.

Toluene, C₇H₈

Toluene is the second member of the aromatic series of hydrocarbons and has a boiling point of 110.5° C.

Its recovery together with benzene and the higher boiling aromatic hydrocarbons is described under the section "By-products from coke oven gas."

A considerable proportion of the toluene extracted is consumed in the motor benzole. During war-time, however, there is a large demand for pure toluene for the manufacture of the explosive, trinitro toluene (T.N.T.).

Toluene is fractionated and refined in the same manner as described for benzene.

Similar standard specifications for toluene have been drawn up by the *National Benzole Association* as in the case of benzole and adopted by the *British Standards Institution* in B.S.S. No. 805-1939.

Pure Toluole Boiling point range	5 per cent.—95 per cent. within 1° C.
and Pure Toluole for Nitration	5 per cent.—97 per cent. within 0.4° C. (between 110° and 111° C.)
90 Toluole boiling point range	5 per cent. max. at 101° C. 90 per cent. min. at 120° C.
95 Toluole boiling point range	5 per cent. max. at 107.5° C. 95 per cent. min. at 120° C.

These products must conform to tests for colour, acid test and maximum sulphur content.

Toluene, although less widely employed in the chemical industry than benzene, is of considerable importance. It is employed in the synthesis of a number of drugs, pharmaceuticals and dyestuffs intermediates. From

toluene can be synthesized such important chemicals as saccharin, chloramine, cinnamic acid and novocain. It is also employed as an industrial solvent.

Its production in India has been taken up on a big scale only during the present war for the manufacture of explosives. The output of toluene in India is $4\frac{1}{2}$ lakhs gallons annually.

Xylene, C_8H_{10}

Xylene forms the third member of the aromatic series. There are three isomeric xylenes (dimethyl benzenes), *ortho*-xylene (b.pt. $144^\circ C.$) *meta*-xylene (b.pt. $139.2^\circ C.$) and *para*-xylene (b.pt. $138.4^\circ C.$).

The xylenes, together with benzene and toluene are recovered from coke oven and gas works gas by the methods described under the section "By-products from coke oven gas."

Motor benzole contains a small proportion of xylenes but these compounds are mostly utilized in coal tar light solvent naphtha, which is a solvent widely used in the paint and varnish industry and as a rubber solvent. Pure xylenes are now assuming some importance in the synthesis of certain fine chemical products as well as for dyestuff intermediates.

Specifications for xylenes approved by the *National Benzole Association* have been standardized by the *British Standards Institution* as B.S.S. No. 458 of 1939.

- | | |
|-------------------------|--|
| (1) 2° Xylene .. | 5 per cent.—97 per cent. boiling within $2^\circ C.$ between 138° — $142^\circ C.$ |
| (2) 3° Xylene .. | 5 per cent.—95 per cent. boiling within $3^\circ C.$ between 138° — $144^\circ C.$ |
| (3) 5° Xylene .. | 5 per cent.—95 per cent. boiling within $5^\circ C.$ between $135^\circ C.$ and $145^\circ C.$ |

The above are acid washed and have a flash point (Abel) of not below $75^\circ F.$

Coal Tar Solvent Naphthas are included in the *British Standard Institution B.S.S.* No. 479 of 1939.

- | | |
|---|---|
| (1) Coal tar solvent naphtha 96/160 | 5 per cent. max. boiling at $125^\circ C.$
96 per cent. min. boiling at $160^\circ C.$ |
| (2) Coal tar solvent naphtha 90/160 | 90 per cent. min. boiling at $160^\circ C.$ |
| (3) Heavy coal tar naphtha 90/190 | 5 per cent. max. boiling $160^\circ C.$
90 per cent. min. boiling $190^\circ C.$ |
| (4) Heavy coal tar naphtha 90/190 (unrectified) | |
| (5) " " " " 90/200 (unrectified) | |

The above heavy naphthas have a flash point of not below $75^\circ F.$ (Abel).

The potential production of solvent naphthas in India is approximately 1 lakh galls. per annum.

Heavy naphtha is also employed as a solvent for varnishes and enamels, etc., and also in disinfection naphthas.

References

- ¹ Lunge, *Coal Tar and Ammonia* (Gurney and Jackson).
- ² Lunge and Keane, *Technical Methods of Chemical Analysis*, Vol. 4 (Gurney and Jackson).
- ³ Spielmann, *Constituents of Coal Tar*, (Longman's Green & Co.)
- ⁴ Warnes, *Coal Tar Distillation* (Ernest Benn, Ltd.).
- ⁵ Banbury and Davidson, *The Industrial Application of Coal Tar Products* (Ernest Benn Ltd.).
- ⁶ Wilson Haigh, *Trans. Min. & Geol. Inst. India*, 1940, 35.
- ⁷ Hoffert and Claxton, *Motor Benzole, Its Production and Use* (National Benzole Association).
- ⁸ Langton, *Blacks and Pitches*, (Ernest Benn, Ltd.).
- ⁹ Hughes, Adams and China, *Tar Roads* (Edward Arnold & Co.).
- ¹⁰ Abraham, *Asphalts and Allied Substances* (D. Van Nostrand Co., Inc.).

HEAVY CARBON, C-13

THE preparation of a relatively stable isotope of carbon, C-13, which will provide the research worker especially the biochemist with a valuable new aid, is announced from America. The Sun Oil Company and the Houdry Process Corporation with the collaboration of a group of scientists, many of whom worked on the atomic bomb, have developed methods for the production of heavy carbon in sub-

stantial quantities. The isotope occurs in natural carbon to the extent of 0.7 per cent. By the use of tracer elements the biochemist has successfully elucidated the mechanism of several organic reactions. The use of an identifiable isotope of carbon holds out far-reaching possibilities and will enable the biochemist to follow stepwise the complex chemical reactions in the living organism.



AUSTRALIAN AGAR AGAR INDUSTRY

By MEL PRATT, *Sydney*

JAPAN has lost a market for yet another commodity. Before the upheaval in the Pacific, Australia was content to import from Japan the whole of her agar agar supply—about 50 tons a year. Now she is in the industry herself, can meet her own requirements, and will soon have a surplus for export.

Agar agar is used in the canning of high-grade meats, such as tongues. It is used in preference to gelatine because it retains its consistency under the high temperatures necessary. Gelatine breaks down. Agar agar also plays an important part in the culture of bacteria. Other commercial uses are in the manufacture of some medicines and confectionery.

Not long after war swept over the Pacific, Sydney people noticed a strange, new activity along the foreshores of Middle Harbour and Botany Bay, two sheets of water well within Sydney's suburban limits. Fishermen were drying vast quantities of seaweed on racks on the beaches. Some people had seen them earlier, scraping the neighbouring sea-bed with weighted rakes, dumping the wet weed into small lighters or scows, and then towing the haul ashore. But few realized even then that they were watching the start of the agar agar industry in Australia.

The Council for Scientific and Industrial Research had known for a long time that the *gracilaria* weed, commonly known as red weed, or blanket weed, would yield a

high percentage of agar agar, but until local production was made necessary because of the war, the Sydney sea-weed "fields" had not been exploited.

Rich Reward

Prior to 1941, Japan was the world's biggest producer of agar agar—about 350 tons a year. Only two other countries were producing this substance; the United States, about 75 tons a year; New Zealand, 30 tons. Sydney fishermen are now taking about 300 tons of *gracilaria* from the harbour bed annually, providing an output of about 60 tons of agar agar.

During the war, fishermen were receiving Rs. 642 a ton for dried weed. Now they are selling it for Rs. 428 a ton, but most of them still make up to Rs. 214 a week, for their overhead is small. The only equipment required, in addition to their boats, is the weighted rakes, which most of them make themselves, a press similar to a wool press, and the drying racks made from lengths of wire-netting supported on wooden trestles.

Australian weed-gatherers have an advantage over those in Japan, because of the location of the *gracilaria* beds. In Sydney the weed grows on a sand bottom and, as it is raked up, it leaves seed-pores behind, which ensure that the weed will go on growing in the same place. In Japan the weed grows on rocks. This means that the *gracilaria* has to be pulled away by the roots. This is a more difficult harvesting method, and one which quickly depletes the deposits.

REVIEWS

An Introduction to X-Ray Metallography.

By A. TAYLOR. (Chapman and Hall Ltd., London), 1945. Pages xi + 400. Price 36s. net.

DURING recent years there have been extensive applications of X-ray diffraction methods for studying metallurgical problems, so much so X-ray analysis has now become an indispensable tool for metallurgical research. The subject has been entirely developed by X-ray crystallographers. As physicists they suffer from the disadvantage due to the lack of metallurgical experience; the professional metallurgists, in spite of their intimate knowledge of metallurgy, are handicapped by the absence of suitable literature from which they could gain sufficient working knowledge of X-ray analysis without going into the intricacies of the science of X-ray crystallography. Recently, however, some books have appeared which meet the requirements of both metallurgists and the X-ray crystallographers.

The book entitled "An Introduction to X-ray Metallography" by Dr. A. Taylor is one of such books. In this book Dr. Taylor has given a connected account of the different methods of studying the various metallurgical problems by X-rays. The author in the first few chapters has given a lucid account of the crystal forms, crystal symmetry, space lattices and space groups in a manner that will be very useful for beginners. The author next initiates the reader into the methods of X-ray analysis by discussing the various methods of obtaining X-ray diffraction patterns. The powder method which is mostly utilized by the X-ray metallurgists has been aptly dealt with in considerable detail, including the various corrections necessary for accurate measurements of lattice perimeters. In the later chapters, a large mass of useful information has been collected together from various journals and classified. The appendix, containing many reference tables, considerably enhances the value of the work as a reference volume to research workers.

The author hopes that the book would be "of service to the student reading for a degree." We feel, however, somewhat sceptic. To serve that purpose, one would expect a

more consistent and clearly defined terminology and a much clearer exposition, particularly in the chapters on "The Study of Thermal Equilibrium by X-ray Methods" and "Grain Orientation." The inclusion of the chapter on "Radiography and Micro-radiography" is a useful feature in view of the recent extensive applications of these methods to industry.

The usefulness of the book has unfortunately depreciated to some extent due to a few inaccurate statements and slips which we hope will be removed in the future editions. Thus, on page 53, the angle ψ shown in Fig. 31(a) does not tally with that given in the text where ψ represents its complement. On page 92, the statements

" $F=3f$ when l is odd and when $h+k=3n+1$ or $3n+2$ "

and

" $F=f$ when l is even, $h+2k=3n+1$ or $3n+2$ "

are apparently wrong in view of the equation

$$F=f\left\{1+\cos\pi l\cos\frac{\pi}{3}(2h+4k)\right\}$$

Among other minor defects, mention may be made of the wrong use of the word lattice which has a definite technical meaning to crystallographers instead of the appropriate word structure in "hexagonal closepacked lattice" (page 38, Table XIX, p. 266, and the Tables in pages 282-286) and the use of Schoenflies notations for space-groups instead of the International Hermann-Mauguin notations.

However, the book will be found very useful both to physicists and to metallurgists who want to apply the methods of X-ray analysis to metallurgical research.

K. BANERJEE.
R. K. SEN.

A Dictionary of Metallography. (Chapman and Hall, London). 1945. Pp. vii+243. Price 15s. net.

The author has treated the subject matter in an excellent and up-to-date manner. The absence of a book of this type has been long felt by metallurgists in particular, and by others interested in the subject of metallography, which according to the author embraces a good deal of chemistry,

physics and physical-chemistry. Although it would have been generally desirable if the book had covered a slightly larger field, one must appreciate the difficulty of doing so without unduly increasing the size. Since, however, this is essentially a reference book, it would have been of general advantage had the author included chemical metallurgy, metalliferous minerals, ore-dressing and mining terms, in order to make this already useful publication a comprehensive survey of the science of metals. The book in many respects is encyclopædic in character, a rather favourable feature for this type of work.

This is a valuable book of reference and deserves a place in every library.

G. P. CONTRACTOR.

"Chemical Industry in India" (Monograph No. 7, All-India Manufacturers' Organization, Bombay), 1945. Pp. viii+235. Price Rs. 5-12.

The monograph under review is the latest in the series issued by the All-India Manufacturers' Organization. It has been compiled from information gathered from various publications on Indian chemical industry and the statistical data have been drawn from official returns, supplemented by replies to a questionnaire sent round by the Organization. An attempt has been made to examine the present position and the future prospects of the various important branches of the chemical industry, such as heavy chemicals, fine chemicals, chemical fertilizers, coal-tar distillation products, dyestuffs, drugs and pharmaceuticals, and alcohol, in the light of the developments that have taken place during the war. The publication gives all the available information and statistical data regarding production of chemicals in India, and also information relating to exports and imports. Comparative statistics have been provided not only for the latest year for which figures are available, but also for a number of previous years. A selected bibliography has been appended.

Considering the difficulties involved in collecting information of this type, it must be said that the effort of the Organization to place before the public a fairly comprehensive account of the chemical industry in India, is an outstanding success. The importance of such a publication which presents clearly all the available facts and figures relating to the industry cannot be overemphasized. The publication is of the utmost value as a

reference book to all those who are interested in the industrial development of the country.

M. P.

The Problems of Sugar Industry in India.

By M. P. GANDHI. (Gandhi & Co., Publishers, Jan Mansion, Fort Bombay), 1945. Pp. 375. Price Rs. 12.

The author of this thesis is already well known to those interested in the sugar industry through his annual reviews, which have been appearing regularly during the past ten years. The publication of the present volume is well-timed, as questions relating to the policy of discriminating protection for the sugar industry are now under consideration.

Fourteen years of protection have witnessed a phenomenal development of the industry in this country. The results have amply justified the policy of protection without which India would have faced a total famine of white sugar during the trying years of war. If arguments are still needed for protection, the author has provided them in full in this volume.

The sugar industry has come to stay, but to place it on an economic and sound basis, efforts are still needed. The problems facing it are threefold. Firstly, the cultivation of sugarcane must be developed on scientific lines to ensure *maximum* yield at *minimum* cost. The responsibility for co-ordinating the policy of manufacturers with the interests of cane-growers rests on the Government as the two seem to be ever in conflict. Secondly, the efficiency of manufacture, which has already increased during the last decade, has still to be improved by co-operative effort of the industrialists and technicians. The utilization of the most important by-product of the industry, viz., molasses, is an urgent problem which has to be solved permanently. Lastly, a definite fiscal policy should be laid down by the Government once for all. A detailed exposition of all the problems implied in the above three viewpoints has been given by Mr. M. P. Gandhi.

The development of a power alcohol industry as a corollary to the development of the sugar industry on scientific lines is very necessary. The author has dwelt in detail on this topic and has given a lucid account of the progress made so far in the country. While it is very necessary to have all legislative aid to establish the use of absolute alcohol in admixture with petrol, a point often missed is the relaxation of the rigours

of an antiquated excise regulation in the face of which a scientific advance of the power alcohol industry cannot be made. When the country was producing alcohol only for consumption as intoxicant liquor, a strict policing by the Government was essential. Despite rigorous excise supervision the liquor industry is making large gains! The power alcohol industry, however, has to exist on maximum efficiency of production on scientific lines, and excise regulations for this industry should obviously differ from those for the liquor industry. The author has omitted this aspect of power alcohol industry.

The readers will find the work quite illuminating. The thesis could have been considerably cut short with advantage by avoiding repetitions of the same topics. Many questions are dealt with at great length, and arguments are long drawn. Much of the book is taken up by printing information which has already appeared in the author's *Annuals*. On the whole, the volume does credit to Mr. Gandhi, who has made a thorough study of the complex problem facing an important Indian industry over a number of years.

G. G. RAO.

Picture of a Plan. By MINOO MASANI. Illustrated by C. H. G. MOORHOUSE (Oxford University Press, Bombay), 1945. Pp. 63. Price, 2 rupees.

The book which may well be called "Planning Without Tears" is a worthy successor to the author's "Our India." Once again the author sets up new standards in writing. The book is at once popular and instructive. The author's racy style and the multi-coloured illustrations make a unique combination.

The book tells the story of the Bombay Plan in simple and homely language. It dwells on the economic reform for ensuring the minimum standard of living for every Indian and explains what the reform means in terms of food, clothing, housing, public health and education. The plan for doubling the income in fifteen years in three leaps is lucidly described, and it is explained how the men and money required for working the details of the plan are to be found. The author then goes on to discuss the matters dealt with in the second part of the Bombay Plan, and tells in simple words how the increase in wealth is to be shared, to what extent the present disparity of incomes is likely to be levelled up, and, finally, what

part the Government or the State is to play in putting the plan into effect.

The author has rendered a great service to the country by this simple and attractive rendering of the Bombay Plan, and it is hoped that editions of the book in all important Indian languages will soon be published, together with the original illustrations.

R. B. PAI.

A NEW CATHODE RAY OSCILLOGRAPH

THE British Electrical and Allied Industries

Research Association have recently developed a versatile and reliable Universal Oscillograph which is suitable not only for general purposes but also for measurements connected with radio interference problems and specially for observations of high frequency transients such as occur in variable band width amplifiers, artificial noise sources, alignment problems, etc. The instrument is adaptable for special tests but convenience of use has not been sacrificed for obtaining versatility. The operating conditions are well below the nominal rating of the components used, thus decreasing the chances of breakdown. The C.R. tube is of the hard type having a 6" screen of green fluorescent colour. The necessary voltages for accelerating, focussing and controlling the brightness of the tube are provided by a half-wave rectifier system, the choice of six anode voltages up to a maximum of 2,250 v. being available by means of a switch. The deflection sensitivity and brilliancy are correspondingly changed, maximum sensitivity being 0.9 mm./volt at minimum voltage. The instrument is provided with eight step switches and nine continuously variable rheostats or potentiometers for controlling the operating conditions. 50 c/s single phase A.C. supply of either 110, 120, 220 or 230 volts can be used for working it. All controls, excepting three, are available on the front panel. There is a terminal desk panel at the back with 26 terminals which afford an easy opportunity to arrange a large variety of circuits for the oscilloscope input. For this purpose an instruction sheet is provided on the inner side of the desk lid. The whole apparatus consists of two main chassis, one above the other, and is so designed that the upper chassis can be hinged back so that all components are easily accessible under full operating conditions.

The hard valve self-contained time base gives a good saw-tooth form and a sweep frequency of 0.5 to 275,000 c/s can be had with 5 to 20 per cent. flyback. A negative pulse derived from the time base circuit and occurring during the flyback period can be applied to the C.R.T. grid to suppress the return trace. The amplitude control is so arranged that it does not affect the speed across the screen. For observations of transients a single stroke time base is available by keeping the time base in a discharged position and switching it on for the duration of the transient. Any external time base can also be applied. In addition, an elliptical time base is incorporated which can be derived from either 50 c/s mains or external frequencies up to about 60 kc/s. This is specially useful for harmonic analysis and pulse work where the absence of a flyback, i.e., observation of the complete cycle, is often welcome.

A selector switch on the front panel permits the use of saw tooth or elliptic time base, or no time base at all. It also permits synchronization to be obtained either by means of the signal under test or by a separate voltage source or by the 50 c/s source.

A special feature of the equipment is the provision of a voltmeter, having a 200 μ A movement, which can be used to get a direct voltage calibration from 0.1 to 200 volts for both A.C. and D.C. The calibration is independent of mains voltage fluctuations. A frequency calibration scheme is also incorporated to adjust variable audio frequencies, up to about 10 kc/s, to multiples of the mains frequency.

Since the C.R. tube used has a maximum deflection sensitivity of about 1 mm./volt, a single stage amplifier has been used which is quite versatile inasmuch as it can be made to handle both A.C. as well as D.C. signals. The operation of the amplifier can be made to be either class "A" with or without cathode degeneration or class "C." The amount of amplification can also be varied by altering the anode load resistance of amplifier. Since the calibration voltage measures the amplifier output on the C.R. tube screen, the amplification produced for any setting must be known in order to calculate the small A.C. signal input. A table is therefore provided inside the desk lid giving all values of the amplifier gain; response-frequency curves for different operating conditions are also supplied.

SWELLING STRESSES IN GELS *

RECENT advances in the development of materials like compressed wood, masonite, synthetic-bonded plyboards, resin-impregnated wood, wood-flour filled plastics, etc., which are entering increasingly into industrial, engineering and building fabrication, indicate the numerous ways in which the uses of wood are being extended. That wood, like other natural materials such as cotton, wool, horn, and leather, is water-sensitive and swells or shrinks in response to changes in the humidity of the surrounding air is well known. Whenever the swelling is subjected to a restraint either by external means or by reason of the existence of the thin sheath-like primary wall that surrounds each wood cell, stresses are set up in the material which may rise to considerable dimensions causing distortion or even rupture of the wood. Normally, the swelling stresses are relieved to some extent by virtue of the presence of void spaces and hollow cells, into which the swelling can proceed causing their cross-sectional distortion; but in resin-impregnated wood owing to there being much less of void space, there is less scope left for the natural swelling to proceed and consequently the swelling pressures exerted in such cases are much higher. Considering the bearing that these swelling stresses have on the mechanical behaviour of wood, and in view of the fact that they vary with the actual moisture-content at any instant, it becomes clear that an exact understanding of the relationships that obtain between the above factors is imperative.

The subject has been dealt with at great length and thoroughness in a report recently issued by the Department of Scientific and Industrial Research, London. The practical importance of a quantitative treatment, in particular the implications of *varying* swelling stresses under changing conditions of humidity on the elastic properties of gels, has been fully brought out in the Report.

Drawing the reader's attention to the obvious analogy between swelling and osmotic pressures it is pointed out, how by abandoning the several misleading simplifications which were introduced in earlier theoretical

* "Swelling stresses in Gels, and the calculation of the Elastic Constants of Gels from their Hygroscopic Properties."—Special Report No. 6, Forest Products, H.M. Stationery Office, London, 1945. Price 1s.

treatment for obtaining the Katz swelling pressure equation, $\bar{p} = -\frac{RT}{M\bar{\mu}} \log H$, the real clue to the connection between elastic constants and swelling pressure can be found. Emphasis is laid on certain points which were not appreciated well enough by previous workers, viz., that the essential property which distinguishes gels from solutions is their rigidity, that hydrostatic pressures alone do not constitute swelling pressures, that the swelling pressure equation which involves merely the properties of the swelling liquid (M , $\bar{\mu}$ and H) and ignored those of the gel substance itself must be necessarily inadequate, that the swelling pressure of a gel held at constant moisture content is not the same as that when at constant volume, etc. Starting from the two empirical observations which characterize all gels, namely, (a) that they swell by sorption of vapours or liquids and (b) that the vapour pressure exerted by the sorbed vapour or liquid is in general less than that of the saturation pressure of the free liquid except that at the limit of sorption the vapour pressure reaches saturation, generalized expressions relating the swelling pressure to the bulk modulus K , the young's modulus E , the Poisson's ratios σ and the rigidity modulus n , are derived by having recourse to a thermodynamic approach and by applying rigorous mathematical reasoning

to the case of an "idealized" gel. When applying them to the case of natural fibrous materials, which constitute an important group of gels, however, their limitations on account of the extreme anisotropic nature of the materials and also on account of their divergence in behaviour from the purely "elastic" type assumed for an "idealized" gel, have to be borne in mind. The reader's attention is drawn in the Report to these limitations and *approximate* mathematical solutions are suggested for use in such cases. The applicability of these expressions and the theory of swelling stresses are illustrated by presenting existing data for the desorption and shrinkage of spruce wood.

Finally, a very interesting new explanation is given in the Report for the phenomenon of sorption hysteresis of gels. In this connection it is pointed out that shear stresses are bound to be set up in the case of any three-dimensional net-work, like that of a gel, for example, on swelling, and that hysteresis can occur only in systems which are capable of sustaining shear stresses. The whole treatment is thorough and rigorous and the thermodynamic approach resorted to in the derivation of the fundamental expressions makes them exact and valid whatever theory one may be inclined to accept for the mechanism of "gelling" or for the structure of the gel.

A. J. R.

INSTITUTION OF ENGINEERS (INDIA)

(Continued from page 548)

knowledge and for the pooling of experience of engineers associated with important engineering projects in India. The *Institution of Engineers* was started with Sir Thomas Holland as its first president and was formally inaugurated on 23rd February 1921, by H.E. Lord Chelmsford. The *Institution* has to-day on its rolls over 3,000 members drawn from all parts of the country. The work of the *Institution* is carried out through its eight local centres at Calcutta, Bombay, Lucknow, Madras, New Delhi, Bangalore, Hyderabad and Lahore. It has its own building at Calcutta which is its headquarters.

The *Institution* holds an Associate Membership Examination twice a year, and issues a quarterly journal for the dissemination of information on the science and practice of engineering in India. It functions as the Indian National Committee of the International Electro-technical Commission and the British Standards Institution. More recently, a committee of the *Institution* prepared a scheme for the setting up of a National Standards Organization in India, which is now under the active consideration of the Government.

P. R. AGARWAL.

BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH

SIXTEENTH MEETING—NEW DELHI

THE Sixteenth meeting of the *Board of Scientific and Industrial Research* was held at New Delhi on 17th January 1946 under the chairmanship of the Hon'ble Sir Ardeshir Dalal. The Board recommended to the Governing Body the renewal of research schemes in operation in the various universities and research laboratories all over India. The following new schemes were recommended :

- (1) Dr. A. N. Lahiri (*Dhanbad*): Physical and Chemical survey of Indian coals.
- (2) Dr. S. K. K. Jatkar (*Bangalore*): Manufacture of formaldehyde from ethyl alcohol.
- (3) Dr. K. R. Ramanathan (*New Delhi*): Radiation equilibrium in the atmosphere.
- (4) Dr. P. K. Kichlu (*Lahore*): Photochemistry of ozone.
- (5) Dr. P. S. Gill (*Lahore*): Correlation of cosmic ray intensity with atmospheric variables.
- (6) Dr. R. L. Sen Gupta (*Calcutta*): Investigation of the mechanism of the production of mesons and their properties with the help of Wilson Cloud Chamber.
- (7) Dr. L. A. Ram Das (*Poona*): Infra-red radiation from the atmosphere.
- (8) Dr. G. P. Kane (*Bombay*): Manufacture of phenol from chloro-benzene.
- (9) Dr. P. C. Guha (*Bangalore*): Manufacture of phenol by the benzene sulphonic acid processes.
- (10) Sir J. C. Ghosh (*Bangalore*): Manufacture of methanol from carbon monoxide and hydrogen.
- (11) Dr. Karimullah (*Delhi*): Investigations on *Kakra Singi*, *Brahmi* and *Brahmi-Manduki*.
- (12) Dr. B. C. Kar (*Dacca*): Chromium plating of glass, wood and other non-metallic materials.
- (13) Dr. Mata Prasad (*Bombay*): Manufacture of sodium chloride for industrial purposes.

- (14) Prof. K. Banerjee (*Calcutta*): X-ray studies of metals and alloys.
- (15) Dr. L. C. Verman (*Delhi*): Powder metallurgy technique with special reference to the manufacture of lubricated bearings and composite metal-graphite brushes.
- (16) Dr. S. K. K. Jatkar (*Bangalore*): Studies in dielectric constants of liquids and solids.

Report of the Dyestuffs Committee.—The Board recommended the adoption of the final report of the *Dyestuffs Committee* and the implementation of the various recommendations made in it for the establishment in India of the manufacture of the 51 dyes mentioned in it within a period of 15 years.

Atomic Research.—The Board recommended the setting up of a Committee consisting of Prof. H. J. Bhabha, Dr. K. S. Krishnan, Dr. M. N. Saha, Dr. D. N. Wadia, Dr. Nazir Ahmad, Dr. Jivraj Mehta and the Director of Scientific and Industrial Research (*Convener*) to:—

- (1) Explore the availability of the raw materials in India capable of generating atomic energy ;
- (2) suggest ways and means of harnessing them ; and
- (3) keep in touch with similar organizations in other countries.

Measurement of Geological Time.—A Committee for the measurement of geological time in India was set up with the following personnel: Dr. D. N. Wadia (*Chairman*), Sir J. C. Ghosh, Prof. M. N. Saha, Director, Geological Survey of India, Dr. M. S. Krishnan, Dr. B. D. Nag Chowdhury, Dr. C. Mahadevan and Dr. P. B. Sarkar.

Beryllium and its Master Alloy.—A Committee consisting of the following members was set up to work out a programme of research on beryllium and its master alloy: Mr. G. C. Mitter, Dr. Mata Prasad, Sir J. C. Ghosh, Dr. P. R. Ray and Director, Scientific and Industrial Research (*Convener*).

The above recommendations of the Board were approved by the Governing Body at their 10th meeting held on the 18th January, 1946.

The Governing Body decided that early steps should be taken for the specialized training of personnel who are selected for the National Physical and National Chemical Laboratories.

The Governing Body re-elected the Hon'ble Sir Akbar Hydari as its Vice-President.

The Budget Estimates of the *Council* for the year 1946-47 were considered and approved by the Governing Body. The Governing Body noted with satisfaction

that with the money provided it would be possible for them to go ahead with the work of construction of the National Laboratories.

The Governing Body noted with regret that the Hon'ble Sir Ardeshir Dalal would be relinquishing his portfolio of the Department of Planning and Development of the Government of India and along with it that of the presidentship of the *Council of Scientific and Industrial Research*. They placed on record their very high sense of appreciation of the extremely valuable services rendered by the Hon'ble Sir Ardeshir Dalal to the *Council* and hoped that he would continue to evince interest in the activities of this organization.

MANUFACTURE OF ATEBRINE IN INDIA

AT the instance of the *Council of Scientific and Industrial Research*, the Government of India have reviewed the position regarding the manufacture of atebaine in the country, and have decided to encourage indigenous production of the drug by providing facilities to Indian manufacturers to import the intermediate chemicals required in its synthesis.

It may be recalled that of all the synthetic anti-malarials so far available to the public (*Paludrin*, the latest I. C. I. discovery, which is claimed to be better than atebaine, has not been yet released for civilian use), atebaine is the most effective against malaria. The *I. G. Farbenindustrie* of Germany held the world patent rights for this drug. After the outbreak of the war, German supplies of atebaine were cut off, and with the fall of Java and other quinine-producing countries in the Far East, there was an acute shortage of anti-malarial drugs all over the world. To relieve the position, His Majesty's Government permitted *May and Baker Ltd.*, *Imperial Chemical Industries Ltd.* and other manufacturing firms, to exploit the patent rights of atebaine held by the *I. G. Farbenindustrie*, under the provisions of the *Enemy Property Act*, and to manufacture and supply the drug for public use. As a result of this action, *Mepacrine* was produced and made available for the use of the Services and the civilians.

(*Quinacrin* is the American substitute for atebaine.)

During the war period, attempts were made in India to manufacture atebaine, but due mainly to the non-availability of the raw materials required and to some extent to the lack of the "know how" of the process, those attempts proved unsuccessful. The *Council of Scientific and Industrial Research* examined the question of atebaine manufacture in great detail, and came to the conclusion that production in India can be facilitated by making the required intermediate chemicals available for manufacturers. A long-range programme of research on anti-malarials has been initiated by the *Council*.

The Government of India have now decided to encourage the manufacture of atebaine in India by providing facilities to Indian manufacturers to import the intermediate chemicals required. The right of exploitation of the German patent is vested in the Custodian of Enemy Property, and the Controller of Patents and Designs in India is empowered to grant licence to Indian firms for its exploitation subject to the fulfilment of the provisions of the Defence of India Rule 84 B(9).

Indian firms interested in the manufacture of atebaine may now apply to the Director-General of Supply, Drugs and Dressings Directorate, for necessary facilities to import the intermediate chemicals.

INSTITUTION OF ENGINEERS (INDIA)

SILVER JUBILEE SESSION—DECEMBER, 1945

THE Jubilee Session of the Institution of Engineers (India) was held at Calcutta, the headquarters of the Institution, on 27th December 1945. The inauguration was performed by His Excellency the Viceroy in the presence of H.E. the Governor of Bengal, Nawab Zain Yar Jung Bahadur and other distinguished guests.

In the course of his inaugural address, H.E. the Viceroy said:—

“India has owed much in the past to the skill and devotion of engineers. In the present, she has a greater need than ever of their services, to further that wide development of her agricultural, industrial and economic progress which it is within her power to make. Such general progress requires scientific planning and it is here that your Institution, which deals with all branches of engineering, seems well fitted to make its contribution.

“There is great need for the establishment of more training schools and colleges for engineers and for the encouragement in every way of the technical skill which India requires for her development. There is no lack of ability if opportunity offers.

“There is also great need for research institutes, so that India may not be dependent on discoveries made abroad and can make her own researches into her particular problems, of which those dealing with water are the most urgent and vital. Besides the normal ones of irrigation, there are many special problems—water-logging, soil erosion, flood control, hydro-electric power—for which research is essential, and research can only be effectively done in India. If any rich merchants in India who have made money during the war—I am advised that there are some who have done so in spite of all hardships and handicaps—are seeking for a suitable means to expend those profits for the public good, I can think of no better object than the establishment of a research institute on India's water problems, on a really adequate scale.

“I was deeply impressed not long ago when I saw the immense destruction of valuable land in Bihar which has been caused by the vagaries of the Kosi River, which is still uncontrolled and still encroaching on rich fields. I have seen, too, some of the water-logged lands of the Punjab, some of the damage caused by the Damodar River, some of the waste caused by erosion, some deserts which might yield rich crops if we could use the water which pours itself unprofitably into some ocean. These are Indian problems for which there should be a research institution planned with lavish imagination. I commend the idea to all those who have the future prosperity of India at heart.

“Your engineers are fortunate in several ways; you can see concrete evidence of what you have done—sometimes, perhaps, too concrete in these utilitarian days; you know that what you have made is of benefit to mankind; and you are entitled to do what we would nearly all like to do occasionally, to dam and blast, without public interest and at public expense. These are some of your blessings, but you

have also hard trials and struggles, many of them against that stern mistress, Nature herself. May you enjoy and profit by your blessings; and may you enjoy and profit also by your struggles, as all true men should do.

“One last word, be as kindly as you can to Nature and disfigure her as little as possible. Public works should not be inconsistent with beauty of design.

“Gentlemen, I congratulate you on your Silver Jubilee, on all the progress you have made since your foundation. I wish you full success in your tasks ahead, the aim of all which must be to make India great, prosperous and contented. May your Golden Jubilee when it comes, be golden indeed.”

After the inauguration ceremony, Nawab Zain Yar Jung Bahadur delivered the presidential address. He stressed the importance of fundamental research for the progress and development of engineering, for which no facilities existed in India. Nawab Zain Yar Jung Bahadur concluded by saying: “We have therefore to rebuild and reshape the whole of our national life and we can take no better resolution on this occasion of the Silver Jubilee Session of the Institution than to pledge ourselves to attack, with all the tools and implements, the machinery and equipment, the mind and imagination of the engineer, the triple alliance of poverty, ignorance and disease which holds our country in its relentless grip.”

Papers on the *Manufacture of Locomotives in India*, by Mr. P. R. Agarwal, the *Dindee Project* by Kwaja Azim-ud-din and the *Hardinge Bridge* by Capt. T. S. N. Rao, were read and discussed during the session on the 27th, 28th and 29th December. A Jubilee Dinner was held and visits were organized to the *Bengal Chemical and Pharmaceutical Works*, the *Palta Water Works*, the *Bengal Electrical Lamp Works*, *Jadavpur Engineering College*, and to *Tata Iron and Steel Works*, Jamshedpur.

It is appropriate to give here a brief history of the *Institution of Engineers (India)*, the Silver Jubilee of whose foundation was celebrated on the 27th December 1945. The *Institution* owes its origin to a widespread demand for an organized society of Engineers which manifested itself after the close of Great War I. The Industrial Commission presided over by Sir Thomas Holland, stressed in its Report, the need for a central agency for the spreading of engineering

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NOTES AND NEWS

Regularity in Cotton Yarn, Slivers and Rovings

PHOTOGRAPHIC testers for the rapid measurement of irregularity of cotton slivers, rovings and yarn have been developed in the Laboratories of the British Cotton Industry Research Association, and described in the *Shirley Institute Memoirs* (1945, 19, 147).

The yarn regularity tester measures the thickness of the yarn compressed between a pair of steel shoes, the pressure between them being 2.5 gms. The motion of the movable shoe which is governed by the thickness of the yarn is suitably magnified by a lever arrangement and is photographically recorded on a bromide strip. The speed of passage of the yarn through the tester can reach the upper limit of 100 inches per minute. In the sliver and roving tester the material passes between two wheels with a rectangular groove in the lower one and a pressure upto a maximum of 15 lbs. could be applied to the sliver. The movement of the upper wheel which depends upon the thickness of the material is magnified and recorded as before. A mechanism is also applied to this instrument by means of which the frequency distribution and the standard deviation of the thickness of the material are easily obtained. The normal speed is about three feet of roving tested per minute.

The two testers have been used to determine the irregularity of yarn and roving. The yarn tester has been modified to give automatically the mean thickness of half inch specimens. In the case of the roving tester the effects of the length of specimen and of the load on the wheel have been considered and the optimum values have been determined. It is clear that it is not so much the variations in the average counts from bobbin to bobbin, but rather the variations over both long and short lengths of yarn or roving from one bobbin, or of the sliver from one can, that are important. The nearest practical approach to an absolute measure of the irregularity is the standard deviation of the weights of very short equal specimens cut from a long length of yarn or roving. But the weighing of samples is neither easy nor automatic. On the other hand the thickness measurement by the regularity tester satisfies both these conditions. Furthermore, measurements of thickness made on the testers are found to be very closely correlated with the weight per unit length and equations have been derived connecting the variation in thickness with the variation in weight.

Investigation of the periodicities in the products of cotton spinning made with the help of the regularity testers shows that after the third draw frame the variability of the material rises rapidly through the speed frames until the roving is two or three times as irregular as the sliver from the third draw frame and there is a further increase in irregularity on the spinning frame. The production of irregular slivers and rovings may be due to mechanical causes as well as to the cotton itself. The tracing made by the testers show that the thick and thin places are not equally spaced nor are of equal magnitude in

different places and this is the true characteristic of the drafting wave. The mean length of the wave depends upon the variety of cotton and the degree of parallelization of the fibres in the sliver before drafting. The amplitude of the wave when draw frame sliver is employed is less than when a card sliver is used. This decrease in amplitude as the fibres become more parallel and less entangled reveals the importance of parallelization of the fibres in the draw frames and by the comber. Further, experimental evidence is brought forward to show that the wave is caused by the floating fibres. The drafting wave is the result of the dragging forward of the floating fibres by those gripped by the fast rollers. It is, therefore, characteristic of the drafting of cotton by means of the ordinary roller system and its amplitude and length depend upon the draft, roller setting, the properties of the cotton and the condition in which the cotton is presented to the rollers.

V. V. G. & R. L. N.

Uranium Sources

Uranium is usually obtained from either pitchblende or carnotite. The former is an amorphous hydrous oxide of uranium. In its crystalline form, uraninite sometimes contains traces of lead, thorium, zirconium, metals of the lanthanum and yttrium groups, calcium, water, iron, argon, radium and helium as decomposition products. Pitchblende itself is said to contain no thorium or rare earths. Other varieties and modifications of uraninite are called cleveite, nivenite and broggerite. Carnotite instead of having the black pitchy lustre of pitchblende, has a canary yellow colour and is a hydrous potassium uranyl vanadate. It usually occurs as impregnations in sandstone. Other uranium-bearing minerals, for the most part mineralogical curiosities, but some of which are mentioned from time to time, include torbernite, zeunerite, autunite, bassettite, uranospinite, uranocircite, uranospathe, tyuyamunite, phosphuranylite, trogerite, uvanite, gummite and walpurgite.

In the United States, uranium production has usually been a by-product from vanadium properties owned or operated by the U.S. Vanadium Corporation and the Vanadium Corporation of America. U.S. Vanadium operates in South-western Colorado, at Uravan and Durango, and the Vanadium Corporation, which probably account for a much smaller uranium output, at Rifle, Naturita and other points in Colorado, and at Monticello, in Eastern Utah. There have been, and there are, several other small individual producers, including Gateway Alloys, Inc., at Gateway, Colorado. Uranium-bearing material has also been reported, and in some instances mined, in Nevada, California, Arizona, Texas, New Mexico, South Dakota, and Eastern Pegmatites in Ontario, Connecticut and North and South Carolina.

Outside the United States, conspicuous deposits of pitchblende have been discovered in the last few years at Great Bear Lake, in North-western Canada, which has recently been the world's principal supplier

of radium. Until the war broke out, radium and uranium were produced in relatively sizable quantities in the Belgian Congo and Rhodesia, and reserves there are believed high in grade and large. Mining by *Union Minière* in the Belgian Congo was resumed in 1942, when the production of uranium ore was 1,021 metric tons, containing 695.6 metric tons of U_3O_8 according to the U.S. Bureau of Mines. Other occurrences are known in Bohemia, Saxony, Bulgaria and Portugal. New discoveries are reported from Soviet Russia, and uranium is a by-product of the shale-oil industry in Sweden. No comprehensive production figures are available, but it is evident that uranium-bearing ores, though not available in any great tonnage, are rather widely distributed, and some 100 minerals are said to contain uranium in detectable amounts, with practically all rocks containing traces.

Before the war, uranium in the United States was principally used as a colouring agent in ceramics, such as for amber signal glass. Uranium has also been made into ferrouanium, for use in the steel industry, largely to get rid of it as a by-product of radium manufacture.—*Mining and Metallurgy*, 1945; —*U.S.I.S., Min. & Met. Eng. Newsletter*, No. 15.

New Methods of Oil Survey

A new oil exploration and production research centre, to be devoted to studying new methods of finding oil and getting it out of the ground, will soon be built in Houston, according to officials of the *Shell Oil Company*. The million-dollar research centre is expected to be completed by spring. It will house the company's recently organized division of exploration and production research, an independent entity within the *Shell* organization. The research programme of the new laboratory will focus attention on augmenting America's petroleum resources by developing new and more efficient methods for discovering oil and for recovering it in quantities from the underground reservoirs in which it is found. The discovery of new reservoirs is becoming increasingly difficult and large quantities of oil in present reservoirs are not being brought to the surface by present production methods. Research in physics, chemistry and geology, as they relate to petroleum exploration and production, will be carried on at the laboratory. It will also serve as an instruction centre for training exploration and production field men in new techniques and methods. Director of the new division is Dr. Harold Gershinowitz, who for the last few years has been research director of the company's manufacturing department in New York.—*Science*, 1945, 102, No. 2654, Suppl., p. 12.

Caffeine

Caffeine will soon be in production synthetically in St. Louis in a vast plant to be constructed by the *Monsanto Chemical Company*. Domestic production of this synthetic caffeine will free the United States from dependency on foreign-produced natural sources. Although scientists have long known how to duplicate the natural product's complicated molecular structure in the laboratory, caffeine until now has been derived almost exclusively from such sources as tea waste and surplus coffee, or indirectly from cocoa cake, a by-product of chocolate manufacture. The new plant will use a process, details of which are not revealed, except that the synthetic material, simulating the process of nature, will be derived from nitrogen from the air and hydrogen

from water.—*Science*, 1945, 102, No. 2654, Suppl., p. 12.

Records of Storms with Radar Equipment

Radar instruments developed for war purposes may play an important part in future weather forecasting, and also make permanent records relative to the nature of storms and their movements for use in the science of meteorology. The progress of the hurricane which swept over Florida in September last, was accurately plotted on film near Orlando, Florida, by Army radar war equipment. Photographs of each radar scope were taken each 15 seconds by electrically operated cameras.

The use of radar to detect storms began at least as early as August 1943. Before that, Army radar technicians had noticed "ghost echoes" on their relatively primitive scopes but did not realize at first that they were caused by thunderstorms. Later they did, and Army weather observers soon learned how to use radar to plot other storms and they later developed better techniques of detection. But the size and violence of the storm of 15th September, and its closeness to the radar station, resulted in new findings about the nature of hurricanes.

Throughout the hurricane the general shape of the disturbance was plainly seen on the micro-wave set, whose energy was reflected excellently from the rain carried by the storm. The storm was seen to be in the shape of a figure six with clockwise spiralling tails. At one time, six distinct tails were observed, three of which were detached and were moving northward ahead of the storm's centre. These tails were deduced to be rain-bearing storm-clouds, or line squalls eight to ten miles in width and from three to five miles apart.

When the hurricane was abreast of the radar station, and only 10 miles away, the radar revealed that the eye of the storm, the low pressure area in its centre, was 12 miles in diameter, and the lack of echoes proved that there was no precipitation within it. The height-finding radar set revealed that the dense cloud deck surrounding the eye extended up to an average height of 18,000 feet.—*Science*, 1945, 102, No. 2652, Suppl., p. 14.

Radar Contacts with the Moon

It is reported that tests carried out at the Evans Signal Laboratory at Belmar, New Jersey, by the Army Signal Corps scientists, have established the possibility of radar contact with the moon. Using specially designed equipment, pulses of high frequency energy were shot into space at the speed of light—186,000 miles per sec.—and echoes were received $2\frac{1}{2}$ seconds later. A United States War Department announcement says, "the experiments have valuable peace-time as well as war-time applications, although it is impossible at this stage to predict with certainty what they will be." One of the possibilities is radio control of long-range jet or rocket propelled missiles circling the earth above the stratosphere.

According to Sir Edward Appleton, it is possible by means of radar to map the moon and study the irregularity of its surface. Other possible applications of radar are radiolocation of meteorite trails, meteorological balloons used for weather research and bursts of electrons in cosmic-ray showers.

The discovery of mysterious radio noise from sunspots is announced by the Department of Scientific and Industrial Research, London. According to a

Reuter's message dated 2nd February the radio noise is heard only from time to time, but had been noticed as being particularly intense during the last few days when the Astronomer Royal has reported that there is now clearly visible on the sun's face the biggest group of sunspots observed since 1926.

The work on the subject began as far back as 1936 when Sir Edward Appleton, the then Professor of Natural Philosophy at Cambridge University, analysed reports from a number of wireless amateurs about a curious "hiss" which they had heard on their receivers. From their reports he concluded that the noise was due to emission of radio waves from sunspots areas on the sun's disc. He also concluded that the sun's emission on 10-metre wavelengths was increased 100,000 times at the time the hissing noise was heard on the earth.

Dearsenication of Sulphuric Acid

An electrolytic method for the removal of arsenic from sulphuric acid has been patented by *Bozels Maletta Societe Industrielle de Produits Chimiques* (French Patent No. 894628 of 1944). The acid is treated with an amount of sulphur dioxide chemically equivalent to the amount of arsenic present. The dioxide is then reduced electrolytically (temp., 40° C.; 4.5 volts; anode current density 10 amp./sq.dm.; cathode current density, 1 amp./sq.dm.) to hydrogen sulphide which precipitates the arsenic in the form of insoluble arsenic sulphide.

Highway Research

The U.S. State of Kentucky, planning a \$75,000,000 post-war highway construction programme, is employing up-to-date research methods. Factors tending to destroy highways and methods of improving construction are being studied under artificial and actual weather and road conditions in a new laboratory at the University of Kentucky, Lexington, which will be maintained by the Kentucky Highway Department. Laboratory work is segregated into four divisions: concrete, bituminous, soil mechanics and chemical. A circular tract will have facilities for applying all conditions of traffic, friction pull, effect of friction braking, heat up to 49° C., cold to -23° C., moisture in the subgrade or foundation speed, load and other factors. It is expected that under this accelerated test, road service equivalent to one year can be produced in ten days to two weeks.—*U.S.I.S., Civ. Eng. Newsletter* No. 14, 1946.

Atomic Research in U.K.

The Government of the U.K. has decided to set up an atomic-energy research and experimental establishment near Didcot. Accommodation is being provided for the establishment at Harwell airfield. The control of atomic research has now been transferred from the Department of Scientific and Industrial Research to the Ministry of Supply. Prof. T. D. Cockcroft has been appointed Director of the Station.

It is revealed that Britain has planned to spend £2,800,000 on atomic research during the 1946-47 fiscal year. Prime Minister Attlee stated in the House of Commons; "Our programme on atomic research in this country is not limited by financial considerations, but by the number of trained scientists and material resources available, especially building and engineering equipment. Within these limits our programme of research is now being developed as rapidly as possible."

Government Fertilizer Factory

"It was announced in a Press notification dated 20th January 1945, that a Mission under the leadership of Sir James Pitkeathly had proceeded to the U.K. for negotiating the purchase of plant for the *Government Ammonium Sulphate Factory* to be erected at Sindri in Bihar", says a Press note dated 17th January 1946. "This Mission was especially charged with the responsibility of investigating the processes and plant employed in the manufacture of ammonium sulphate, both in the U.K. and in the U.S.A., with the object of securing for India the most up-to-date plant possible for the production of this type of fertilizer from indigenous materials.

"After lengthy investigations with U.K. and American experts, the Mission had submitted its recommendations, and on the basis of these recommendations the Government of India have now sanctioned the negotiation of agreements for the supply of plant and machinery for the factory, and for the erection of the factory. Two contracts are contemplated: one with a leading firm of American consultants for the design of the whole factory, supervision of the erection of the factory, and seeing it into production at its rated output; the other with a firm representing a consortium of British chemical plant manufacturers, who will arrange the supply of the necessary plant and its erection, under the supervision of American experts.

"To supply the plant for this factory in the time required, it will be necessary to call upon the resources of a large number of firms including boiler-makers, manufacturers of turbo-alternators, suppliers of electrical equipment, suppliers of mechanical handling and weighing equipment, in addition to utilizing the resources of the chemical engineering industry for the supply of the main chemical plant. The supply of the major part of the plant will be by competitive tender. It is anticipated that large orders for fabricated steelwork, pipe-work, tanks, vessels, etc., will be placed by the main contractors referred to above with Indian firms. In this way, it has been possible to secure the fullest Anglo-American collaboration in providing a plant of the most up-to-date design, and incorporating the best experience of both countries, whilst at the same time employing to the fullest possible extent the resources of Indian industrialists and Indian labour in the supply of such plant and equipment as can be made in India.

"Government are confident that, as a result of the work carried out by the Pitkeathly Mission, the Sindri factory, when completed, will be one of the most modern ammonium sulphate fertilizer factories in the world, incorporating the latest improvements known to science, both in England and in America, and capable of supplying fertilizer at the lowest possible cost to the cultivator consistent with the utilization of indigenous raw material."

Manufacture of Dyestuffs in India

Tata—I.C.I. Agreement.—An agreement for the establishment in India of an industry for the manufacture of dyestuffs, and the necessary development to meet Indian market requirements, was announced in London on 28th December 1945.

It was disclosed that the *Imperial Chemical Industries* and *Tatas* will jointly form a Development Company under a Chairman appointed by *Tatas* to undertake preliminary work and substantially to promote and manage the public manufacturing

company. Both the capital and the directorate will be predominantly Indian, the announcement said.

The arrangements provide that the *I.C.I.* will supply the necessary technical information and knowledge at its disposal and that until such time as manufacture in India is capable of meeting the full demand of the country, dyestuffs made in India and those imported by the *I.C.I.* will be sold jointly so as to make them available to the consumer at all times.

By virtue of this agreement, it was announced, India will be able to establish a highly important complex industry vital to her economic development. The agreement is intended to run for a period of 20 years.

Indian Central Jute Committee

Mr. I. G. Kennedy, Chairman of the *Indian Jute Mills Association*, was unanimously re-elected Vice-President of the *Indian Central Jute Committee* for another term at the half-yearly winter meeting of the Committee, which concluded on 23rd January 1946.

The *Indian Central Jute Committee*, which is responsible for all organized scientific research on jute, from the field to the factory and thence onwards to the various markets of the world, has been carrying on its work through four main technical sections, besides the Administrative and Publicity Sections. The Committee having come into existence soon after the breaking out of World War II, the activities of the Committee had perforce to be limited. The war having ended, the need was keenly felt for an overall expansion and consequent reorganization of the technical sections of the Committee. The need for the expansion of the Committee's *Agricultural Research Laboratories* at Dacca was felt to be very pressing even in the midst of the war. The Committee in 1944 approved of a reorganization scheme involving an expenditure of about Rs. 4½ lakhs non-recurring, and about Rs. 1,30,000 recurring. With the approval of the Government of India this scheme has begun to be given effect to in instalments.

The meeting which concluded on Wednesday accepted, with some modifications, the schemes recommended by the expert sub-committees regarding the expansion of the *Technological Research Laboratories* at Tollygunj, and the *Economic Research and Marketing Sections* at the Headquarters, the first-named at a cost of about Rs. 13 lakhs non-recurring and about Rs. 3 lakhs recurring.

As the *Indian Jute Mills Association* has also a research institute of its own, it was recommended that while work on the different items of the programme accepted for the *Indian Central Jute Committee's Technological Research Laboratories* proceeded, the Director of the latter and that of the former "could maintain contact and arrange to dovetail the work as far as possible."

The *Technological Research Laboratories* when reorganized will have seven technical departments—three each on physics and chemistry and one on spinning and weaving, and the programme of work may be put under five broad heads, viz., (i) *Fundamental Work on the Raw Material*, (ii) *Applied Work on the Raw Material*, (iii) *Spinning*, (iv) *New or Extended Uses for Jute* and (v) *Testing*.

The expanded Economic Research Section will be divided into three categories, the first dealing with the agricultural economic side of jute, the second with industrial economics, and the third with the statistical branch working as a lynch-pin between the former two. Among the main items of the pro-

gramme of work are included (i) the study of the American market, which is the most important mart for Indian jute and jute goods, and (ii) a study of the world consumption of jute—a picture of the structure of the world market for jute and jute goods.

With regard to the establishment of a Jute Museum, it was decided to go ahead with the work of preparing one set of exhibits at present, after which the question will be reviewed, the Director of Agriculture, Bengal, assuring the Committee that the Government of Bengal, when approached, would assist in providing necessary accommodation.

Jute Mills in Egypt.—The *Indian Central Jute Committee Bulletin* (Jan. 1946) reports that under the aegis of the Egyptian Government a jute mill was started during the war to meet its requirements. It now produces 2,000 tons or 54,000 maunds of jute fabrics, ropes, twines and sacks. The mill is reported to have a manufacturing capacity of 3,000 tons or 81,000 maunds per annum. Before the war, Egypt imported over 5,000 tons or 135,000 maunds of jute fabrics, and approximately 12,000 tons or 324,000 maunds of sacks. The present production, therefore, covers only a part of the country's requirements. Even if the manufacturing capacity of the mill were to be used to the full extent, Egypt would still have to import four-fifth of her needs.

Indian Central Sugarcane Committee

The Government of India have placed at the disposal of the *Indian Central Sugarcane Committee* a sum of Rs. 1 crore and 25 lakhs for the development of the sugarcane industry.

To utilize this fund various agricultural and technological research schemes were considered by the Committee at its fourth meeting held in New Delhi on 8th February under the chairmanship of Sir H. R. Stewart.

The developmental work will consist of establishment of seed nurseries and provision for (a) manures of the right type, (b) qualified technical personnel to carry the results of research to sugarcane growers, (c) an efficient Watch and Ward Service for protection of crop against pests and diseases, and (d) a soil extension service to advise sugarcane growers.

The Committee decided to finance a five-year scheme dealing with an expedition to collect wild forms of *Saccharum spontaneum*. The discovery that cultivated canes could be crossed with this wild grass and the subsequent production from that grass of the well-known Coimbatore varieties have revolutionized sugarcane growing and manufacturing industry in the country during the last quarter of a century. The Committee felt that the possibilities in this connection had not yet been exhausted and the potentialities of the fresh material which this expedition would provide would be determined at the Central Sugarcane Breeding Station at Coimbatore.

A Crop Weather Scheme was also financed to take up long-term research on the correlation between climatic factors and sugarcane growth and yield. The Committee also recommended that the Sugar Controller for India be requested to accept a basic grade standard for *khandsari* sugar and to fix a suitable price, allowing a discount for the qualities which were lower than the basic standard.

At its last meeting the Committee had decided to set up its own Technological Institute linked and located with its Central Agricultural Research Station. The selection of a site for the twin institutes was left to a Sub-Committee which is expected to

make its recommendations shortly when a final decision will be taken.

The Committee adopted a resolution recommending that an Agricultural Officer with experience in sugarcane be appointed on the permanent staff of the Committee to advise on technical matters.

Penicillin Production in India

At a meeting of representatives of industrialist concerns interested in the manufacture of penicillin convened on Thursday, 7th February, by the Director-General of Industries and Supplies, many aspects of penicillin production were discussed and the difficulties in the way of establishing manufacture on a commercial scale were considered. It was decided that concrete proposals should be forwarded as soon as possible for Government's consideration by the firms interested in the penicillin industry.

D.D.T.

Tests at Gosford, New South Wales, Australia, confirm that nicotine should be added to D.D.T. spray used on fruit trees, to combat the increase of aphids on treated plots. Mites on plants treated only with D.D.T. were found to have increased phenomenally. This was due, apparently, to the destruction of parasites which had helped to keep the mites in check.

Aircraft Industry in India

The possibility of establishing an aircraft industry in India is being examined by the Government, according to a note appearing in *Capital* (7th February 1945). It is stated that the industry, if it is decided to establish it, will be a State industry.

A nucleus for the industry already exists in this country. The Government of India, during the war, had set up twenty aircraft assembly and repair units, four of which at Bangalore, Poona, Barrackpore and Dum Dum, were major maintenance units. These units are equipped with the latest type of machinery and plant. About two hundred Indians were trained during the war by highly skilled British and American technicians who operated these units.

Government, therefore, feel that this valuable material should not be lost but should be made use of in the development of post-war civil aviation in this country. The airway companies will need repair shops for their craft. India is fast becoming air-minded and will soon have a home market for aircraft. The defence needs of India will, likewise, create a demand not only for aircraft, but also for the maintenance of aircraft.

A Technical Mission, consisting of Mr. J. V. Connolly and Mr. L. R. Barrett of the Ministry of Aircraft Production and Mr. J. D. North and Mr. S. P. Woodley nominated by the Society of British Aircraft Constructors, has arrived in India this week at the invitation of the Government of India in order to advise them on the technical aspects of the establishment of an Aircraft Industry in India.

Technical Committee on Ports

The Government of India have appointed a Technical Committee on Ports under the chairmanship of Sir Godfrey Armstrong, Port Planning Officer of the War Transport Department, Government of India.

The Committee, which will submit its recommendations within four months, will investigate whether a sheltered deep sea port on the east coast of India for accommodating ships of large size at all seasons

of the year is required, and if required, what measures are necessary for establishing it.

The Committee will also consider whether there is justification for converting any minor ports on the coast of India into major ports, whether there are any other projects for construction of major ports and what steps are necessary to develop minor ports in order to meet probable demands of coastal shipping traffic.

Announcements

Indian Science Congress Association. The following scientists have been elected Sectional Presidents for the forthcoming Annual Session at Patna (January 1947):—*Mathematics*, Prof. D. D. Kosambi; *Statistics*, Mr. R. C. Bose; *Physics*, Dr. K. Banerjee; *Chemistry*, Dr. P. K. Bose; *Geology*, Dr. C. S. Pichamuthu; *Botany*, Dr. A. C. Joshi; *Zoology*, Dr. G. D. Bhalerao; *Anthropology and Archaeology*, Mrs. Iravati Karve; *Medical and Veterinary Sciences*, Dr. G. Panja; *Agricultural Sciences*, Mr. N. L. Dutt; *Physiology*, Prof. S. A. Rahman; *Psychology and Educational Science*, Mr. P. S. Naidu; *Engineering and Metallurgy*, Mr. H. P. Bhaumic.

Central Institute of Applied Psychology.—At the Annual General Meeting of the Indian Science Congress, held on 5th January 1946, a resolution supporting the proposal for the establishment of a Central Institute of Applied Psychology in India at an early date, and the appointment of a Sub-Committee to report on the Standard Time for India, were passed.

The following members were elected to the Executive Council for the new year: Messrs. K. S. Krishnan (*Allahabad*), S. N. Bose (*Calcutta*), W. D. West (*Calcutta*), M. R. Siddiqui (*Hyderabad*), S. K. Mitra (*Calcutta*), K. C. Sen (*Bangalore*) K. Biswas (*Calcutta*), S. L. Hora (*Calcutta*), B. Mukherjee (*Calcutta*), and R. C. Majumdar (*Delhi*). The following members were elected to the Council:—Messrs. B. Visvanath, Nazir Ahmad, G. P. Majumdar, P. S. Gill, S. K. Mitra, B. Narayan and Miss L. A. Baker.

National Institute of Sciences of India. At the Annual General Meeting of the National Institute of Sciences of India held at Bangalore on the 1st January 1946, the following were duly elected officers and members of its Council for 1946:

President: Mr. D. N. Wadia (*New Delhi*).

Vice-Presidents: Sir S. S. Bhatnagar (*Delhi*) and Prof. H. J. Bhabha (*Bombay*).

Treasurer: Dr. B. C. Guha (*New Delhi*).

Foreign Secretary: Sir J. C. Ghosh (*Bangalore*).

Secretaries: Rai Bahadur S. L. Hora, (*Calcutta*) and Prof. D. S. Kothari (*Delhi*).

Editor of Publications: Dr. J. N. Mukherjee (*New Delhi*).

Members of Council: Dr. Bashir Ahmad (*New Delhi*), Prof. K. N. Bahl (*Lucknow*), Dr. S. K. Banerji (*New Delhi*), Dr. Verrier Elwin (*Patangarh, C.P.*), Brigadier E. A. Glennie (*Delhi*), Khan Bahadur M. Afzal Husain, (*New Delhi*), Prof. M. O. P. Iyengar (*Madras*), Prof. K. S. Krishnan (*Allahabad*), Prof. P. C. Mahalanobis (*Calcutta*), Dr. B. N. Prasad (*Allahabad*), Dr. H. S. Pruthi (*New Delhi*), Prof. M. Qureshi (*Hyderabad-Dn.*), Dr. L. A. Ramdas (*Poona*), Rai Bahadur J. M. Sen (*Krishnagar*), Prof. M. R. Siddiqui (*Hyderabad-Dn.*), Lt.-Col. S. S. Sokhey (*Bombay*) and Dr. A. C. Ukil (*Calcutta*).

Sir Robert Robinson, Waynflete Professor of Chemistry in the University of Oxford, has been elected President of the Royal Society of London in succession to Sir Henry Dale.

Reports from States and Provinces

Madras

The Godavari Project

REPRESENTATIVES of the Madras and Hyderabad Governments recently met in conference at Hyderabad (Dn.), to discuss the proposed Ramapada Sagara Project over the Godavari River at Polavaram.

The representatives of the Madras Government put forward the case of Ramapada Sagara Project both for the sake of economic development in Madras and on a national basis to solve the food problem in South India at the earliest possible time. This scheme is estimated to produce an additional supply of one million tons of rice yearly.

The representatives of the Hyderabad Government put forward the seriousness of the submergence of the Kothagudem Coal Mines, roughly estimated to have a reserve of five hundred million tons, and stated that these coal mines, apart from being a national asset of Hyderabad, were of great importance to the whole economy of South India. Hyderabad also had their open, Godavari plan, which envisages utilization of waters of the Godavari in their territory and also schemes contemplated on major tributaries of the Godavari. These schemes would materially assist the food situation in South India.

The Governments adopted a resolution requesting the Government of India to appoint a Technical Commission to consider the best way in which waters of the Godavari might be utilized by the Governments of Madras and Hyderabad for the earliest and fullest possible addition to the food production of South India consistently with the optimum use of the natural wealth involved.

The resolution further stated that "subject to the findings of the Technical Commission, special officers may be appointed by both the Governments to work together and survey and evaluate the lands and surface assets to be submerged by the Ramapada Sagara Reservoir. These officers will report to their respective Governments."

Polytechnic of Coconada

The foundation-stone of the Andhra Polytechnic Institute was laid by Sir S. V. Ramamurthy at Coconada on 4th February. He also declared the Institute open. Sir Ramamurthy said that it was one of the six institutions which the Government of Madras had decided to open on the recommendation of the Committee on Technical Education. The Government has also decided to open 15 industrial schools on a regional basis. The industrial school to be attached to this polytechnic will provide for courses in general mechanics, carpentry, weaving, metallurgy, casting, blacksmithy, electrical wiring, auto-servicing, handloom weaving and fishery technology. The course in each subject will be for 18 months in the school and 6 months in a factory.

Other Polytechnics will be established at Vuyyaru, Hindupur, Madras, Calicut and Mangalore. The Polytechnic at Coconada involves a capital expenditure of Rs. 14 lakhs and a recurring expenditure of Rs. 2 lakhs. Three-year courses will be provided in

six branches of engineering. The ultimate strength of each branch will be 60 boys at 20 a year, and the total strength at the end of three years for the courses will be 360 boys.

Bombay

A scheme for the construction of a big dam at Vir, near Poona, at a cost of nearly one crore and seventy lakhs, is now under the consideration of the Bombay Government. The construction of the dam will commence as soon as the Government sanctions the scheme. His Excellency the Viceroy, along with the Governor of Bombay, visited the site where the dam is proposed to be built, on 11th January.

The construction of the dam will increase considerably the irrigated areas in the Deccan. The Nira canals irrigation which benefits the districts of Poona, Satara and Sholapur and the Bhor and the Akalkot States will be augmented by nearly 60 per cent. and the annual irrigation of these canals will rise to 29,000 acres perennial and 218,000 acres seasonal. The storage of the Bhargar dam, which is the source of water for the Nira canals, will be supplemented by 9,600 million cubic feet on completion of the scheme.

The dam is proposed to be built in an area where *jowar* and sugarcane are under cultivation, but in order to increase food supply in the province it is hoped to encourage *jowar* cultivation.

The completion of the work of the dam is expected to take eight years.

Cochin

Peringalkuthu Hydro-electric Scheme: The project contemplates the harnessing of a portion of the waters of the Chalakudy River, which has a drop of about 500' at Peringalkuthu. The catchment of the river at the spot is about 400 square miles. The masonry overflow dam across the river will be about 30' high, with a pressure tunnel of 60 square feet. The maximum power that can be generated will be of the order of 10,000 kilowatts.

The voltage will be stepped up to 66,000 volts and transmitted to Chalakudy, where it will be connected to the 66,000-volt line under construction from Alwaye to Trichur. There will be extra high tension sub-stations at Ernakulam, Kodakara and Trichur for stepping down to 11,000 volts for distribution.

If the scheme is fully developed, the entire needs of the State may be met. The final estimates of the project are under preparation.

Industrial Board.—On the recommendation of the Industrial Development Committee, the Cochin Government have appointed an Industrial Advisory Board, whose function will be to advise the Government on matters connected with the industrial development of the State.

The Chief Engineer will be the Chairman, and the Deputy Secretary to the Government (Post-war Reconstruction), Secretary. The following are the members of the Committee: The Conservator of Forests, the Controller of Finance, the Director of Industries and Commerce, Dr. K. N. Menon, Kerala Varma Thampuran, Rao Sahib C. P. Lonappan and Mr. K. P. Rau.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the Gazette of India, Part II—Section I, for the period December 1945—January 1946. Patents from the Council of Scientific and Industrial Research are indicated by an asterisk.*]

32257. AUTOMATIC AND SEMI-AUTOMATIC TELEPHONE EXCHANGE SYSTEMS. : *Identification of the class of service to which calling lines are entitled is made by electronic discharge devices responding to characteristic negative d. c. potentials.*—Standard Telephones and Cables Ltd.
32822. THE USE OF MOLASSES, JAGGERY OR GLUCOSE : *In preparatory boiling processes in dyeing, bleaching and mercerising of textile goods.*—Dyer.
32899. CHAIRS AND LIKE ARTICLES : *Comprising two independent side frames, a back plate, detachably secured to the side frames, a detachable seat and detachable arm rests.*—Hardwicke and Hardwicke.
32973. ADMINISTRATION OF ANAESTHETICS : *Apparatus for administering anaesthetics, comprises two bags.*—Medical and Industrial Equipment Ltd.
32975. APPARATUS FOR ADMINISTERING ANAESTHETICS : *Comprises a gas bag, control device for gas flow, jet, venturi tube, and adjustable means for admitting secondary gas, such as air.*—Medical & Industrial Equipment Ltd.
30161. DIRECTIONAL SHORT-WAVE AERIALS. : *A single straight conductor and a plurality of other conductors surrounding it and spaced from it.*—G. E. C. Ltd.
31329. COUPLING FOR PIPE LINES : *Sleeve threaded on pipe lengths and adapted to be parted to rotate adjacent pipe length.*—Iraq Petroleum Co., Ltd.
31449. SPACING AND TYING DOUBLE SHUTTERING FOR MOULDING A CONCRETE WALL OR LIKE BUILDING PART : *Cross ties having end formations for prescribed shutter spacing and holding the walls against displacement from said spacing.*—Rumble.
31450. SHUTTERING FOR CONCRETE : *Separate panels assembled edgewise in rows and waling members characterised by stiffness against lateral bending, included in the joints.*—Rumble.
31567. OVERFLOW IMMERSION WATER-LIFT : *Cylinder with a spring at its end for pressing a spindle valve, moving up and down vertically as persons walk to and fro on the lever.*—Pillai.
31817. IMPROVING THE ODOUR ASSOCIATED WITH BENZENE HEXACHLORIDE : *Boiling a suspension of benzene hexachloride in aqueous nitric acid of constant boiling composition.*—I. C. I. Ltd.
32009. STAINLESS STEEL : *Desulphurization of a bath of stainless steel by addition of burnt lime and a fluxing agent in iron-chromium bath.*—Alloy Research corpn.
32024. INTERCHANGEABLE MATRIX TREAD VULCANIZING MOLD : *Bed plate, head plate, matrix assembly with heating means and means releasably securing the assembly to prevent its radial displacement and permit its removal.*—Super Mold Corpn. of California.
32029. PRESSES OR THE LIKE : *Pair of complementary mould sections opening and closing by relative angular movement and means for transversely moving one section.*—Dunlop Rubber Co., Ltd.
32122. ELECTRIC SIGNALLING SYSTEMS : *Different pairs of stations are connected together by hold signals and plurality of pulses sent from one station to the other are changed in length, for transmitting information.*—Standard Telephones and Cables Ltd.
32253. EXTRUSION OF THERMOPLASTIC MATERIALS : *At a temperature above softening point and cooling under pressure.*—I. C. I. Ltd.
32266. COIN-FREED REFRIGERATED VENDING MACHINE : (i) *Insulated casing, (ii) a base with valve control delivery aperture, (iii) a magazine having central refrigerating chamber; heat insulating vacuum shell enclosing receptacle; package chutes, surrounding the chamber. Open bottom to delivery aperture; heat conductors between chute and interior of vacuum shell, (iv) a coin controlled operating means to rotate magazine and open delivery aperture.*—Bouracier and Whitlock.
32310. SULPHUR TRIOXIDE : *Contacting a mixture of SO₂ and O₂ with a mixture of an oxygen compound of vanadium and alkali metal sulphate.*—E. I. Du Pont de Nemours and Co.
32351. SIGNAL TRANSLATING SYSTEMS : *For phonograph record reproduction comprise a pair of rectifiers having, a common output resistance, separate input circuits tuned to a pre-determined high frequency oscillations by a common tuning condenser having a mobile electrode.*—Radio Corpn. of America.
32419. LIGNIFORM ARTICLES. : *Moistening fibres of cellulosic or ligno-cellulosic bodies, kneading with starch, and proteid paste, mixing lac, rosin and pigment, and moulding.*—Behera.
32547. AUTOMATIC STROKERS : *Lower part of the fuel container, close to a turn-table and having a lateral opening with a diverter plate across the turn-table.*—Barker and Elston.
32563. AN APPARATUS FOR MANUFACTURING *papad, chapati, and other similar articles* : *Pairs of rollers geared to produce equal or different surface speed with equal number of revolutions, automatic oiling and flour dusting arrangements and adjustable scrapers.*—Ghatay and Ghatay.
32615. GAUGING APPARATUS : *Means for supporting a component to be gauged and a master and a member currying style and movable in two directions at right angles.*—Bowness.
32735. COTTON CLEANERS : *Agitating elements on the lower row of cylinders consist of serrated disks to form a screen and on the upper row of cylinders consist of spikes.*—Continental Gin Co.
32940. REGENERATIVE FURNACES, STOVES AND THE LIKE : *In regenerative furnaces ribbed tubular flue inserts are provided installed in flue.*—Seaver.

33017. **WHEELS** : *The space, between the load supporting means connected to the hub and rim is filled up by a resilient material.*—Maclean.
33018. **CYANAMIDE** : *Slurrying calcium cyanamide with water, precipitating calcium from the slurry and maintaining the pH of the slurry at 4.0 to 7.2 and temperature at 0° to 55° C.*—American Cyanamid Co.
33027. **FLEXIBLE SEALING DEVICES** : *Sleeve with tubular body of flexible material provided internally with springs.*—Tecalmit Ltd.
33029. **SHEET METAL CANISTER** : *Pressing a floored cup, removing the floor to form open ended sleeve, fitting lid to best end and fixing bottom.*—S. T. Leigh & Co., Pty. Ltd.
33031. **MAGNETIC COUPLINGS** : *Coupling members having projections or teeth magnetised by a field magnet having stationery magnetising coils.*—Pensabene.
33066. **REFINING OF CRUDE OLEFINIC NITRILES** : *Distilling therefrom an azeotropic mixture of the nitrile and water and separating water from the distillate.*—American Cyanamid Co.
33149. **TELEPHONE RELAYING AND AMPLIFYING MEANS FOR THE AID OF DEAF OR LIKE PERSONS** : *Electromagnetic, microphonic and piezo-electric types of pick-up attached to telephone ear-pieces.*—Horvitch.
31013. **ACTIVATION OF PLATINUM CONTAINING CATALYSTS** : *Treating platinum containing catalysts with aqueous solution got by action of sulphur dioxide and metallic iron in presence of water.*—I. C. I. Ltd.
31034. **CALCIUM SALTS OF 2-(P-AMINO BENZOL-SULPHONYLAMINO)-4, 6-DIMETHYLPYRIMIDINE AND OF N4-ACYL-DERIVATIVES THEREOF** : *Pyrimidine derivative is allowed to react with calcium hydroxide or a soluble calcium salt.*—Cilag, Chemisches Industrielles Laboratorium A. G.
31435. **BEAT-UP MECHANISM OF LOOMS FOR WEAVING** : *Mounting the beat-up comb between two frames for rapid movement and stopping the loom if the shuttle is not boxed at beat-up.*—Shimwell.
31452. **CONTAINERS** : *Comprising a body having a mouth provided with a wall terminating in an annular shoulder internally of said container.*—Glocker.
31498. **DETERMINING AND RECORDING THE STRESSES IN WIRE ROPES, CHAINS AND THE LIKE** : *Light rod connected to one fixed point of the link and with a light lever pivoted to the other fixed point, and adapted to impart motion to a stylus.*—British Ropes Ltd.
31622. **JOINTING TERMINATING OR REPAIRING THE COVERING OF AN ELECTRIC WIRE OR CABLE** : *By moulding a dough comprising polyvinyl chloride on the covering and heat treating.*—British Insulated Cables Ltd.
31628. **ROLL AND METHOD OF CASTING THE SAME** : *Casting in a chill mould and closely jacketing the casting with heat retaining sheating.*—Jamshedpur Engineering & Manufacturing Co., Ltd.
31669. **CANNING PROCESSES AND APPARATUS** : *Manufacturing a can body, filling and locating a lid, passing to a vacuum seamer and their passing to an oven.*—Bach and Paton.
31733. **PREPARATION OF PEANUT PROTEIN** : *Treating peanut with alkali solution whose pH is at least 11.0.*—I. C. I. Ltd.
31734. **REMOVAL OF MAGNESIUM HYDROXIDE FROM WATERS CONTAINING MAGNESIUM HARDNESS** : *Adding raw water and aqueous alkali to an agitated aqueous suspension of magnesium hydroxide crystals.*—I. C. I. Ltd.
31896. **DISPENSING MIXTURES OF HIGHLY VOLATILE AND NON-VOLATILE LIQUIDS WHILE MAINTAINING A UNIFORM PROPORTION THEREOF** : *Maintaining constant proportion of mixtures of highly volatile and non-volatile substances with open communication of vapour and liquid phases in two containers.*—Westinghouse Electric & Mfg., Co.
31911. **ALKYLATION OF ISOPARAFFINS** : *Pentene fraction obtained from a distillate produced in the cracking is used as an alkylating agent for isoparaaffins.*—Anglo-Iranian Oil Co., Ltd.
31983. **ROTARY VALVE ASSEMBLIES FOR INTERNAL COMBUSTION ENGINES** : *The provision of gas sealing ring relieves tapered surfaces from the sealing function and also prevents leakage from and to either side of the ring valve member.*—Aspin.
32003. **COLOURED IMAGES** : *Shutter aperture with plurality of radial sections having different colour filters each operative during exposure.*—Locan.
32051. **SAFETY RAZORS** : *Blade inserted in gripping head of the handle and pressed by a rod.*—Rolls Razor Ltd.
32132. **PADLOCK CASINGS** : *Two closed wall structures open at ends, one fitting over the other and closing its ends except for apertures for the shakee limbs.*—Holan.
32205. **A HOIST CONTROL SYSTEM FOR ALTERNATING CURRENT DRIVES** : *Unbalancing the voltage through impedance interposed between one terminal of motor and supply.*—Westinghouse Electric & Mfg., Co.
32212. **BUILDING BLOCKS** : *Moulding machine has a moveable base, a core part projecting through it with means for supporting joining members, and means for raising the movable base.*—C. Bryant & Son Ltd.
32395. **SOCKETS OF ELECTRIC COUPLINGS** : *Clamps or plates adapted to engage with a plug pin and a terminal or conductor at their ends.*—Crabtree & Co., Ltd.
32529. **BANK STRIPS FOR USE, FOR INSTANCE, IN AUTOMATIC TELEPHONE SYSTEMS** : *Comprises insulating frame on which terminal pins are embedded cross-wise and extending out either side.*—Standard Telephones and Cables Ltd.
32603. **HEAT EXCHANGE DEVICES** : *Assembling elements of matrix by subjecting tubular elements to a pressure difference and bonding by brazing.*—I. C. I. Ltd.
32893. **LIGHT CELLS FOR HOLLOW ROOFS AND FLOORS** : *Wooden frame work covered with tarred roofing cardboard and straw, bamboo or grass matting.*—Keller.
32962. **ELECTRICAL SYSTEMS OF CONTROL FOR LIFTS** : *Controlling a plurality of inter-connected lifts.*—Bernier.
33071. **GARMENT SLEEVE STEAMER AND STRETCHER** : *Two members, engaging inside of the sleeve, stretch the sleeve and steam is admitted inside the sleeve.*—United States Hoffman Machinery Corp.
- * 33077. **PLASTIC COMPOSITIONS FROM PULVERISED MICA** : *Adding mica powder with glycerine—gelatine gel.*—Ray.
33080. **LIQUID ELEVATING APPARATUS** : *A float actuating a duplex valve controlling compressed air supply to an ejector and float chamber.*—Gresham & Craven Ltd.

33102. IRON POWDER : *Disintegrated cast iron particles heated with sodium carbonate, cooled and again disintegrated and treated with water.*—Freeman.
33224. PREPARING AND SPINNING JUTE AND OTHER BAST FIBRES : *Winding sliver into rolls delivered at third drafting operation and positioning the rolls above the drafting mechanism.*—Douglas Fraser & Sons Ltd. and Fraser.
30756. TELESCOPE OPTICAL SYSTEMS : *Intermediate body of glass between objective and eyelenses and making optical contact.*—Bart & Stroud Ltd.
31107. THERMOSETTING RESINS : *Adding mono-ether of polyhydroxy alcohol to aminoplastic resin.*—British Industrial Plastics Ltd.
31901. TREATMENT OF NON-WOOLLEN TEXTILE FIBRES, YARNS OR FABRICS TO OBTAIN INCREASED STIFFNESS AND OTHER EFFECTS : *Exposing fibre at elevated temperature to the combined action of water vapour and the vapour of a vinyl compound.*—I. C. I. Ltd.
31979. ELECTRIC SIGNALLING SYSTEMS : *Electric selective signalling system, similar selection units pyramidally arranged for successive selection in response to successive signals of a set of varying signals, each effective in a single unit conditioned by preceding signals.*—Standard Telephones and Cables Ltd.
32012. DIE CASTING MACHINES : *Plurality of injection cylinders mounted for rotation and brought selectively into operative association with mould.*—Plasticast Developments Ltd. and Stock.
32157. PHENANTHRIDINE DERIVATIVES : *Reducing phenanthridine compound containing nitro group and alkylating the product or hydrolysing phenanthridine compound containing carbalkoxy amide group and alkylating the product.*—Walls.
32295. S-VALEROLACTONE : *S-Hydroxyvaleric aldehyde or its isomer, epoxy 1—5 pentanol-5 is reacted with oxygen.*—I. C. I. Ltd.
32520. BISCUITS : *Forming paste of cooked wheat and boiled potato adding ripe banana.*—Chadray.
32575. PRODUCER GAS : *Carbonising coal in fluid state and treating with oxygen containing gas produced in different vessels.*—I. C. I. Ltd.
32651. BELLS : *Vertical pin, mounted on base plate, hold bell dome opening in operating lever allows the lever freely to operate V-shaped striker.*—Sen.
32866. INTERMEDIATE EXPLOSIVE PRIMERS : *Comprising a cast explosive charge and a smaller charge of compressed explosive more sensitive to initiation by the impulse of detonation than the cast explosive.*—I. C. I. Ltd.
33026. A SUBMERGIBLE PUMP : *Pneumatic or steam pressure admitted above water in the container; floats actuating the pressure admission and discharge valves.*—Dias.
33086. FILLING SUPPORTS FOR BAGS, SACKS AND THE LIKE : *Two arms movable towards and away from one another and forming a bag supporting frame.*—Tate and Cooke.
33089. BRANCHED CHAIN ALKENES : *Contacting alkenes with an alumina silica catalyst at 300°—500° C.*—Depenning.
33169. AN ELECTRIC CLOCK : *Lever pivoted to pendulum drives a ratchet wheel. A wheel coupled to ratchet wheel operates a trip mechanism allowing a lever to fall and push the pendulum.*—White.
33171. PROJECTING TRANSPARENCIES : *Inserting adaptor between the condensing lens system so that transparency may be projected under full intensity of light.*—British Acoustic Films Ltd.
33262. SHELLAC BLEACHING : *Dissolving shellac in organic solvent and admixing sodium chlorite solution.*—The Mathieson Alkali Works.
33290. ELECTRICAL NETWORKS : *Integrating network comprising a series resistance, a shunt condenser a diode across the resistance.*—Siemens Brothers & Co., Ltd.
33327. HAND KNITTING APPLIANCES : *A headed knitting needle separable along its stem into at least two portions and a separate stem member.*—Clifford.
26872. PIPING ELEMENTS : *Middle portion of reinforced concrete and two metal end-pieces with hook-shaped parts.*—Societe Anonyme Des Hauts Fourneaux Et Fonderies De Pont a Mousson.
31122. SHEET GLASS : *Introducing gaseous medium into drawing chamber to counteract convection near the drawn sheet.*—Pittsburgh Plate Glass Co.
31238. SPONGE RUBBER ARTICLES : *Continuous production of sheet of sponge rubber on a moving belt.*—United States Rubber Co.
31989. POSTAL FRANKING MACHINES : *Two sets of levers and segments for operating respective meters are located on either side of the printing drum.*—Smith.
32898. LIFTING AND PULLING MECHANISM : *A clutch member, in threaded engagement with a shaft on which a chain sprocket for lifting chain is fixed, is interposed between a driving member and the casing.*—Hinchcliffe and Smith.
32919. CARRIERS FOR ELECTRIC CARTRIDGE FUSES : *Two oppositely disposed sides capable of being sprung apart by the endwise insertion of a cartridge fuse into the holder portion.*—W. T. Henleys Telegraph Works Co., Ltd.
33235. DRIVING DEVICE FOR THE FEEDING WORK OF SEWING MACHINES : *In a forked lever revolves a sleeve axially adjustable on a bearing shaft. The axis of the sleeve and the axis of its bearing shaft make an angle.*—Brutch & Co.
33274. OVERALL CHAINS FOR ROAD VEHICLE WHEELS : *Two series of coupling chainlinks provided on each side of the overall chain.*—Kennedy.
26668. YARN FOR ROTARY AND SPINNING DEVICES : *Yarn before winding on the rotary spooling member applied at least once on said member or on the yarn already wound.*—Frenkel.
31401. KNEE-JOINT FOR PROTHESES : *Two arm lever device pivotally connected with shin member and thigh casing.*—Fahlstorm.
31840. KNITTING MACHINES AND METHODS : *Looper forms new loops through first one and then another of a coursewise series of previously formed loops by guard and accepting members.*—Smith and Smith.
32213. TREATMENT OF CEREALS FOR CONVERTING AND ENRICHING THE ENDOSPERM OF SAID CEREALS : *Grain is kept in closed vessel having high vacuum and next treated with hot water and after permitting enzymic action it is steam treated and dried.*—Huzenlaub, and Rogers.
32250. WHARF-SPINDLE OR WHARF-FLYER ASSEMBLIES IN AND FOR SPINNING AND LIKE FRAMES AND PARTICULARLY TO WHARF-FLYER ASSEMBLIES IN AND FOR FLYER-SPINNING FRAMES : *Spinning spindle or flyer on one side of wharf-board and wharf on the other.*—Morrison and Gunn.

32454. VERTICAL STEAM BOILER : *Comprising an internal downcomer, an annular combustion chamber between the downcomer and the boiler shell structure bounded at top and bottom by tube plates carrying water tubes, a furnace connected to combustion chamber by a flue, and an uptake for escape of gas.*—Fleming.
32906. AUTOMATIC OVERFLOW GATES SUCH AS FOR CONTROLLING THE WATER-LEVEL IN A RESERVOIR, RIVER OR CANAL : *Gate structure is of aerofoil form and pivots about an axis which lies in the plane of resultant hydrostatic pressure.*—Ferguson.
32914. LOCKING MECHANISM FOR SAFES AND THE LIKE : *Oppositely disposed transmitting elements fixed to its adjacent bolt carrying side member and having their working surfaces facing each other and each face co-operating with its adjacent side of lock bolt.*—Godrej & Boyce Mfg., Co., Ltd.
32958. MICROPHONES : *Combination of circular-diaphragmed and strip-diaphragmed microphones, diaphragm centres being in close proximity.*—Standard Telephones and Cables Ltd.
33019. COMPRESSED TABLETS AND THE LIKE FROM FINELY DIVIDED INGREDIENTS : *Compressing material in a porous metal die housed in a non-porous enclosure and means for excluding liquid lubricant through pores.*—Glaxo Laboratories Ltd.
33049. ELECTRIC STOP-MOTIONS FOR TEXTILE MACHINERY : *Tappet-lever resting upon a fulcrum and oscillated by an eccentric and engaging a spring-loaded push rod when in operative position.*—Howard and Bullough Ltd. and Airey.
33050. CENTRIFUGALLY OPERATED ELECTRIC SWITCHES : *Movable contact enclosed in a housing formed on a pulley rotating together with a spindle, but insulated from each other.*—Howard and Bullough Ltd. and Airey.
33234. LEVELLING INSTRUMENT : *Comprising a series of reflecting surfaces arranged relatively to eye piece, one reflecting surface movable and constrained to assume normal position one to gravity.*—Cowley.
27440. INVESTIGATION OF THE FORMATIONS TRAVERSED BY A BORE-HOLE BY DETERMINING THEIR MAGNETIC PROPERTIES : *Lowering apparatus along a bore hole and measuring variations in the induction effects of the magnetic field in geological formations.*—DePenning.
28413. RADIO RECEIVING AND TRANSMITTING SYSTEMS : *Auxiliary transmitter to provide interference pattern to eliminate strong unwanted signals from another transmitter.*—Robinson.
28414. RADIO RECEIVING AND TRANSMITTING SYSTEMS : *Means for receiving signals from distant transmitter and radiating signals of the same frequency to produce the resultant retroaction of negative sign.*—Robinson.
28962. FERMENTATIVE PRODUCTION OF A MIXTURE OF FATTY ACIDS : *Subjecting a carbohydrate to fermentation by a bacterial culture isolated and propagated from soil in which had been cultivated beetroot and the like.*—Weizmann.
30118. AIRCRAFT STRUCTURES : *Skin plating is attached to longitudinal members and stretched over shaped ribs to be subjected to circumferential tensile stresses.*—Vickers Armstrongs Ltd.
31364. FOODSTUFFS AND ANIMAL FEEDING STUFFS AND PREPARATIONS FOR ADDITION THERETO : *One or more of the adjuvants in aqueous solution or suspension is intimately mixed with an absorbate and spray dried.*—A. Green.
31521. LIQUID METERS, PARTICULARLY WATER METERS : *Shutter or division plate is arranged so as to oscillate about a vertical axis in unison with the rotary motion of the piston.*—Stewart, Shaw and Curtis.
31645. SHEET WRAPPING MATERIALS AND MATERIALS COMPRISING LIGHT FILTERS : *Transparent sheet wherein is incorporated, in a state of fine division a colourless stilbene derivative.*—British Cellophane Ltd.
31685. EXTRACTION OF CELLULOSE AND FIBRE FROM FIBROUS PLANTS : *Stalk and the peel are heat treated in water containing a silicate.*—Thom.
31813. PURIFICATION OF POTABLE WATER : *Subjecting the water to treatment with activated silica.*—Cookson.
31897. LOW-DENSITY CELLULAR MATERIAL : *Adding a froth stabilizing agent to a solution of a soluble alginate, aerating and thereafter drying.*—Jones Bonniksen and Cefoil Ltd.
31942. INTERNAL COMBUSTION ENGINES : *Engine component having surface exposed to hot gases constituted by a layer of corrosion-resistant metal and having a body of copper base alloy.*—The Bristol Aeroplane Co., Ltd. and I. C. I. Ltd.
32008. STAINLESS STEEL : *Smelting a charge including chrome ore in a first furnace and then refining and deoxidizing the impure steel in a second furnace.*—Alloy Research Corp'n.
32081. MOUNTING A PUMP ON A CYCLE OR LIKE VELOCIPED : *Piston rod and fulcrumed lever fixed to frame and pump operated by lever.*—Hakim.
32354. BAGASSE AS FUEL : *Burning bagasse under air supply producing gases used for heating boiler water.*—Chand.
32611. SEALING CLOSURE MEMBERS TO GLASS ENVELOPES : *Mounting closure member within the tubular envelope heating the envelope from outside at the level the ridge on the closure member and pressing the tubes inwards by a roller.*—G. E. C. Ltd.
32793. INSULATING FOAM MASSES ON A SYNTHETIC RESIN BASIS AND A PROCESS FOR THE MANUFACTURE OF THE SAME : *Melamine-formaldehyde turned into foam and dried.*—Ciba Ltd.
32909. DOLL-HEAD BEARINGS : *Three pressure-closed ball-and-socket joints arranged at three corners of a triangle.*—Roberts and Gordon.
32921. MIXED FERTILIZER AND METHOD OF MAKING THE SAME : *Mixing ammonium nitrate and calcium carbonate in the proportion of 2 : 3 to 3 : 2 with 10 per cent. of water.*—American Cyanamid Co.
32937. ELECTRIC FILTERS : *Apparatus wherein composite current undergoes commutation, then applied to low-pass filter and then synchronously re-commutated.*—Radio Transmission Equipment Ltd.
33296. STABILIZATION OF ACRYLONITRILE AGAINST DETERIORATION : *Adding a stabilizing agent consisting of ammonia and/or ammonium carbonate and/or products resulting from the reaction of ammonia with acrylonitrile to acrylonitrile.*—American Cyanamid Co.
33297. PREPARATION OF GUANIDINE SALTS : *Effecting a reaction between cyanamide, an ammonium salt and free ammonia at a temperature between 75° and 180° C.*—American Cyanamid Co.

ELECTROLYTIC REDUCTION OF NITRO COMPOUNDS

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PART I.—THE ELECTROLYTIC REDUCTION OF NITROBENZENE

THE reduction of aromatic nitro-compounds in alkaline media leads generally to the production of hydrazo compounds which, on treatment with mineral acids, undergo the "benzidine transformation" to the diamines of the diphenyl series.

The manufacture of benzidine and its analogues is of great importance to the dye-stuff industry, since these compounds are intermediates leading to the direct cotton colours. Benzidine itself was discovered by Zinin¹ in 1845, but its real importance dated from 1884 when Bottiger² prepared Congo Red which could be applied direct to cotton without a mordant.

On the large scale, the hydrazobenzene required for the preparation of benzidine was made by the reduction of nitrobenzene in alcoholic solution with zinc and caustic soda³. The cost of production was considerably cut down by the Weiler-ter Meer process⁴ in which nitrobenzene was reduced in aqueous suspension with specially treated iron and alkali. However, this modification is admittedly difficult to carry out⁵ and not applicable to nitro-compounds other than nitrobenzene with success.

The application of electrolytic methods to the production of organic compounds has been engaging the attention of technical electro-chemists for a long time. The advantages of the electrolytic over the chemical method are several. Among them the following may be mentioned:—

- (1) Expensive reducing agents like zinc, tin, etc., are dispensed with. Except in the case of the very cheapest reducing materials like iron, the cost of current in an electrolytic reduction process is much lower than that of other reducing agents⁶.
- (2) The products obtained by electrolytic methods are usually purer, since there are no sludges of inorganic by-products to remove, and

- (3) The electrolytic processes provide greater ease of control over the operations.

It is necessary at this stage to give a resume of the more important papers and patent specifications on the electrolytic production of benzidine, so that the basis on which the experimental work is detailed in this paper may be clearly understood.

Haussermann⁷ was the first to describe the electrolytic reduction of nitrobenzene in alcoholic caustic soda. The hydrazobenzene was converted to benzidine which was obtained in a yield of 60 per cent.

During the period 1894 to 1906, nearly a hundred patents were taken out in Germany alone on the production of organic compounds by electrolytic methods, and no less than 40 of these were concerned with the production of benzidine. The first of these was that of Straub⁸ who obtained hydrazobenzene in 85 to 90 per cent. yield by conducting the reduction in alcoholic potash. Wulff⁹ effected an improvement by substitution of sodium acetate for the caustic alkali, which led to lesser tar formation and longer diaphragm life. On the laboratory scale, this method leads to excellent results, but the use of alcohol on the technical scale has many disadvantages,^{10, 27} chief of which are loss of solvent by evaporation, high cell resistance, dilution of alcohol by flow of water from the anolyte, fire hazard, etc.

Elbs¹¹ suggested the reduction of nitro-compounds without a solvent, the depolariser being maintained in a state of emulsion by stirring. Based on this valuable idea, a number of patents have been taken out, of which the following are the most important:—

1. The reduction of nitro-compounds is carried out in alkaline emulsion upto the azoxy stage, the solution then acidified and the reduction continued, leading to the production of benzidine in the electrolytic cell¹².

2. The reduction is carried out on similar lines, but a diaphragm is dispensed with by the use of a small anode of iron¹³.
3. The reduction of azoxy compound in acid solution is rendered smooth by the addition of vanadium¹⁴, titanium¹⁵ or chromium¹⁶ compounds, but according to Engelhardt¹⁷, the addition of these compounds leads to greater amine formation.

In all these three procedures, the formation of benzidine sulphate in the electrolytic cell is likely to interfere with complete reduction by entrapping the azo compound and also raise the cell voltage unduly by forming deposits on the cathode and on the diaphragm.

4. The reduction of nitro-compound in alkaline emulsion is said to be carried through to the hydrazo stage by the addition of the oxides of tin, zinc or lead¹⁸, the hydrazo compound formed being removed by a solvent¹⁹ or mechanically²⁰.
5. The use of a solvent is avoided by stopping the reduction when the product contains only 50 per cent. of the hydrazo compound, separating and treating the low melting mixture of azoxy and hydrazo compounds with acid and returning the azoxy compound to the electrolytic cell²¹.
6. A diaphragm is dispensed with by conducting the reduction in a solvent like benzene, the cathode being set at the interface of the two layers and rotated at such a speed that neither a too fine nor too gross an emulsion is formed²², but the advisability of conducting reductions without a diaphragm has been questioned by many authorities²³.

The reduction of nitro-compounds in alkaline emulsion with sodium amalgam²⁴ (obtained from mercury cells for the production of caustic soda) is also worthy of note, but the method cannot be termed strictly electrolytic.

The methods outlined in the preceding paragraphs involve either the use of a solvent (which is a non-electrolyte like alcohol or benzene) or the maintenance of the depolariser in a state of emulsion by stirring. Based on the observation of McKee and Lloyd²⁵ that concentrated solutions of salts

of aromatic acids had good solvent properties towards organic compounds, McKee and Heard²⁶ investigated the electrolytic oxidation of many substances in concentrated solutions of aromatic sulphonates, and McKee and Brockman²⁷ successfully reduced nitro compounds to azo compounds in sodium cymene sulphonate solution. McKee and Gerapostolou²⁸ later found that concentrated solutions of mixtures of sodium and potassium xylene sulphonates were excellent solvents for nitro-compounds and particularly suitable for employment as solvents in electrolytic reduction. These authors have carried out an extensive study of the reduction of nitrobenzene, nitrotoluene and nitroanisole in xylene sulphonate solution and have also studied the reduction of other nitro-compounds like *para*-nitrophenol, nitronaphthalene, etc. For a detailed account of the advantages stated to be gained by employment of this method a reference must be made to their publications²⁵⁻²⁷.

A common charge levelled against electrolytic methods⁶ is that the electrolytic plant is larger, more expensive, requires more expert attention, and high upkeep, due to severity of operating conditions. It is essential, if the electrolytic method is to succeed, that the cell be of a simple design and easy to operate. The necessity for a large amount of experimental work becomes obvious, when it is considered that research publications usually ignore the practical aspect of the problem and patent specifications often incorporate superfluous data in an effort to cover up the crucial and important points.

The main objective with which the experimental work presented in this paper was carried out was to find out which of the several promising methods was suitable for large-scale production and the optimum conditions for operating the selected method. Of the several methods cited in the preceding paragraphs, the following were considered worthy of trial: Reduction of nitrobenzene (1) in alcoholic solution, (2) in a solution of sodium and potassium xylene sulphonate, and (3) in alkaline emulsion using a diaphragm cell. In the following section, the results obtained are presented together with a discussion of the merits of each process.

Experimental

Reduction in Alcoholic Solution.—A small-scale experiment was carried out according

to the method described by Elbs²⁹. 30 gms. of nitrobenzene in 240 c.c. of 70 per cent. alcohol and 8 gms. of sodium acetate were reduced at a monel gauze cathode of 1.5 sq. dm. effective surface. 18 gms. of pure hydrazobenzene were obtained (80 per cent.).

In a large-scale experiment, 350 gms. of nitrocompound were reduced in a solution of 100 gms. of sodium acetate in 2 litres of 70 per cent. alcohol. For the first 5 hours it was possible to pass only a current of 5 amps. at 8 volts. The conductivity gradually improved, but it became obvious that reduction in alcoholic solution would demand operation at uneconomical voltages. In order to prevent the azo and hydrazo compounds from being thrown out of solution due to dilution effects, it was also necessary to add further quantities of alcohol. The results of several experiments proved that the method of reduction in alcoholic solution was unsuitable for operating on the industrial scale.

Reduction in Saturated Solution of Sodium and Potassium Xylene Sulphonates.—The reduction of nitrobenzene in xylene sulphonate solution has been described in elaborate detail by McKee and Gerapostolou²⁸. In an attempt to reproduce the results, it was found that the views expressed by McKee, *et al.*,²⁸ on the utility of this method for the large-scale production of hydrazo compounds could not be accepted in their entirety. The experimental work is based entirely on the work of McKee and a description of the procedure is given here only because the findings are at variance.

The xylene sulphonic acid was prepared as follows.—1,000 gms. of xylene (*Bararee Coke Co.*, Commercial quality) were stirred with 550 c.c. of sulphuric acid ($d = 1.84$) without allowing the temperature to rise above 70° C. The stirring was continued for about 2 hours, the mass then cooled and treated with 225 c.c. of water. The top layer consisting of unreacted xylene was separated (430 c.c.). The aqueous layer was left in the refrigerator overnight and the xylene sulphonic acid then filtered through a sintered funnel. Yield, 985 gms. The sodium and potassium salts were prepared by neutralizing the solution of the sulphonic acid with the corresponding carbonates and evaporating to dryness.

A saturated solution of 30 per cent. potassium and 70 per cent. sodium salts had a density of 1.25, and about 100 gms. of this

mixture dissolved in 100 gms. of water at room temperature. This solution was employed as solvent in the reductions. 1 mol. of sodium hydroxide was added to a litre of the solution.

The small-scale experiments were conducted in a 2-litre pyrex beaker, which served as the cathode chamber. The cathode consisted of two concentric cylinders, 4" and 3" in diameter and 5" high, and was constructed according to the description of McKee *et al.*²⁸ for their type S-2 cells. The beaker was provided with a lid of asbestos cement with holes suitably drilled for passages of cathode and anode leads, stirrers, glass tube inlet for anolyte, etc. The stirrers were of monel. The anode was a platinum strip inside an alundum cup of the dense type with sulphuric acid of 40-45 per cent. strength as anolyte.

The large-scale experiments were conducted in a monel cell constructed according to the design for type B-2 cells described by McKee. The cell was a cylindrical vessel of monel, 10" diameter and 9" high. Additional cathode surface was provided by a set of 20 vanes, 4" by 2", welded to two monel rings 9" diameter and 4" apart. All the joints were autogenously welded. The vessel was provided with a lid of asbestos cement, with holes suitably drilled for the passage of two stirrers with monel blades and for anode leads. The anodes were of platinum inside two diaphragms of alundum of the dense type and the anolyte was sulphuric acid of 40-45 per cent. strength.

At the end of the reduction, the catholyte was diluted with four volumes of water, and the precipitate obtained filtered and pressed. The azobenzene was removed by washing the residue lightly with petroleum ether. The filtrate was concentrated till crystals just appeared and in some cases re-employed for the reductions.

The results obtained in this study are given in Table I.

Although a large number of experiments were carried out, it has not been possible to list all of them because of troubles encountered in many cases during the reductions, and the results obtained were, therefore, unrepresentative. The following defects were noticed in the operation of this method.

- (1) There was excessive diffusion of the catholyte into the anolyte, even with dense alundum diaphragms. In a cell

TABLE I. *Reduction of nitrobenzene in sodium and potassium (30 per cent.) xylene sulphonates.*

No.	Nitrobenzene gms.	Volume of catholyte cc.	Current strength	Duration hrs.	Total current amp. hrs.	Current density amp./sq.dm.	Hydrazobenzene gms.	Yield %	Azo-benzene gms.	Yield %
1	150	900	13 hrs. at 10 amp. 7 hrs. at 4 amp.	20	158	2.0 0.8	80	73	10	9
2	150	750	12 hrs. at 12 amp. 8 hrs. at 5 amp.	20	184	2.5 1.0	66	60	24	22
3	150	750	13.5 hrs. at 10 amp.	13.5	135	2.5			95	86
4	1,000	4,000	25 hrs. at 40 amp. 5 hrs. at 25 amp.	30	1,125	1.0 0.6	550	73	100	13
5	1,000	4,500	22 hrs. at 40 amp.	22	880	1.0			670	89
(Brass 6 cell)	1,000	5,000	21 hrs. at 40 amp. 1 hr. at 10 amp.	22	860	1.0 0.25			450	60 (aniline 20 per cent.)

The reductions were conducted in all cases continuously.

taking 1 kg. of nitrobenzene nearly two litres of sulphuric acid of 45 per cent. strength had to be used during a run of 30 hours. The anolyte cups had to be taken out several times and flushed with water since the sulphuric acid gets extremely dark and viscous and increases the cell resistance

- (2) The xylene sulphonate solution deteriorates both in conductivity and in solvent power with repeated use. Treatment with lime and extraction with xylene as suggested by McKee *et al.*²⁸ was not very effective in improving the quality.
- (3) The purity of the hydrazobenzene was also not satisfactory, especially when the reduction was carried out in the solvent used previously.
- (4) The hydrazobenzene produced was always mixed with 10-20 per cent. of azobenzene, even when a large excess of current had been passed and the reduction conducted at as low a current density as 1 amp./sq. dm. This is due to the fact that hydrazobenzene is not very soluble in the xylene sulphonate solution and is thrown out of solution, entrapping in the process some azo compound.
- (5) It would appear that reduction in xylene sulphonate solution would be very suitable for the production of azo compounds in good yields but not for hydrazo compounds. The cell voltage is also appreciably high. In a cell handling 4.5 litres of xylene sulphonate solution and 1 kg. of nitro-compound and with dense alundum diaphragms and an effective cathode surface of 40 sq. dm., 8 volts were necessary for passing 40 amps.
- (6) Apart from the fact that the use of a volatile solvent is avoided, reduction

in xylene sulphonate solution does not offer any special advantages over older methods.

Reduction in Alkaline Emulsion.—In the introductory section a survey of the more important work carried out on the reduction of nitrobenzene in alkaline emulsion has been given. It will be seen that all the recorded information on the subject is in the form of patent specifications. It was, therefore, considered necessary to undertake a systematic study of the reduction of nitrobenzene in alkaline emulsion. The preliminary experiments were conducted at monel, lead and iron cathodes.

Monel Cathode.—Both the small and large-scale experiments were conducted in cells similar to those employed in xylene sulphonate reductions.

Lead Cathode.—The cathode chamber was a cylindrical vessel of lead, 8" diameter and 9" high. Additional cathode surface was provided by a lead cylinder, 5" diameter and 5" high, placed inside the lead vessel, and two slots were cut in this cylinder to allow free play of the stirrers. The cell was provided with a lid of asbestos cement which was screwed to the vessel flange by bolts and nuts.

Iron Cathode.—The iron cell was of the same design and size as the lead cell.

The anolyte in all cases was a 30 per cent. solution of sodium hydroxide inside an ordinary porous pot. The anode was of iron. The strength of the anolyte decreases during the course of the reduction, and there is excessive frothing when it drops to below 15 per cent. The anolyte is then withdrawn and replaced by 30 per cent. alkali.

In the earlier experiments, the solid reduction products sticking to the cathode and the diaphragm were scraped off and filtered at the end of the reduction. The residue was extracted with alcohol to free

it from inorganic matter (spongy lead, etc.). The alcohol was then distilled off and the hydrazobenzene freed from any azobenzene by washing with petroleum ether. These operations were found to be time-consuming and leading to partial reoxidation of hydrazobenzene. The following procedure was adopted in the later experiments. When 90 per cent. of the theoretical current had been passed, 100 cc. of xylene were added for every 100 gms. of nitro-compound taken. The reduction was continued till the xylene layer had become colourless. The xylene layer was then separated hot, filtered from any lead and poured into ice and hydrochloric acid (2.2 mols.), stirred for five hours in the cold after which the temperature was raised to gentle boiling. The acid layer was separated and the benzidine precipitated as the sulphate by treatment with sulphuric acid. An average yield of 80 per cent. was obtained in the benzidine transformation in experiments carried out under the same conditions with hydrazobenzene. In the experiments carried out at lead and iron cathodes, the yield of hydrazobenzene has been estimated from the weight of benzidine sulphate obtained, by assuming a 80 per cent. yield in the conversion. The azobenzene was isolated from the xylene layer.

From the preliminary experiments (Table II) it was seen that:

- (1) Nitrobenzene is reduced at a monel cathode to a mixture of hydrazobenzene and azobenzene, the hydrazobenzene constituting nearly 50 per cent.
- (2) The addition of lead oxide carries the reduction to completion, less than 5 per cent. of azo compound being found in the end product.
- (3) At a lead cathode, more than 90 per cent. of hydrazobenzene and 4 to 5 per cent. of azobenzene are obtained. The addition of lead oxide is not necessary but the cathode is corroded by the action of alkali to some extent and the dissolved lead redeposited in a loose form.
- (4) At an iron cathode, in the presence of lead oxide, the yield of hydrazobenzene was 92 per cent. with less than 4 per cent. azobenzene.
- (5) The current efficiency of the process is good, only 10 to 20 per cent. of excess current having to be passed over that required theoretically.

- (6) The formation of a crust of hydrazobenzene on the cathode and diaphragm was a drawback in the earlier experiments. The addition of xylene at a suitable stage was helpful in carrying the reduction to completion and in the removal of hydrazobenzene.

Both from the point of view of ease of operation and yield and quality of hydrazobenzene, the reduction of nitrobenzene in alkaline emulsion proved to be superior to the method of McKee (*loc. cit.*).

The preliminary study having shown great promise, it was considered necessary to undertake a systematic study of the reduction of nitrobenzene in alkaline emulsion with special reference to the following: influence of current density, influence of concentration of alkali and depolariser, and influence of addition agents. Iron was selected as the most suitable cathode for the purpose both from the results obtained in the preliminary experiments and from the point of view of technical application at a later stage.

In carrying out an extended study as proposed, it was essential to have a cell of a simple design, which could be easily assembled and in which all the factors except the variable factor under study could be reproduced to the minutest detail possible. A description of the cell designed for this purpose is given in the next paragraph. This cell has been of great value not only in this case but also in conducting related studies with other nitro-compounds like *ortho*-nitrotoluene and *ortho*-nitroanisole, etc., in alkaline emulsion.

The cathode chamber consisted of an oval iron vessel whose axes were 7" and 5" and 5" high, provided with a flange of 1" width (Figures 1 and 1a). Additional cathode surface was provided by eight bits of iron gauze, 8" long and 2.5" wide, arranged along the wall of the vessel, four on either side, and secured to the vessel by bolts and nuts. The same bolts were utilized for connecting the vessel to the negative terminal of the generator. The vessel was provided with a heavy cast iron lid fitted to the vessel over a rubber washer and secured by three "G" clamps suitably placed. The cast iron cover had the following special features. There were two bearings for the passage of two stirrers of the paddle type and the escape of vapours through the bearing was prevented by a gland arrangement of the

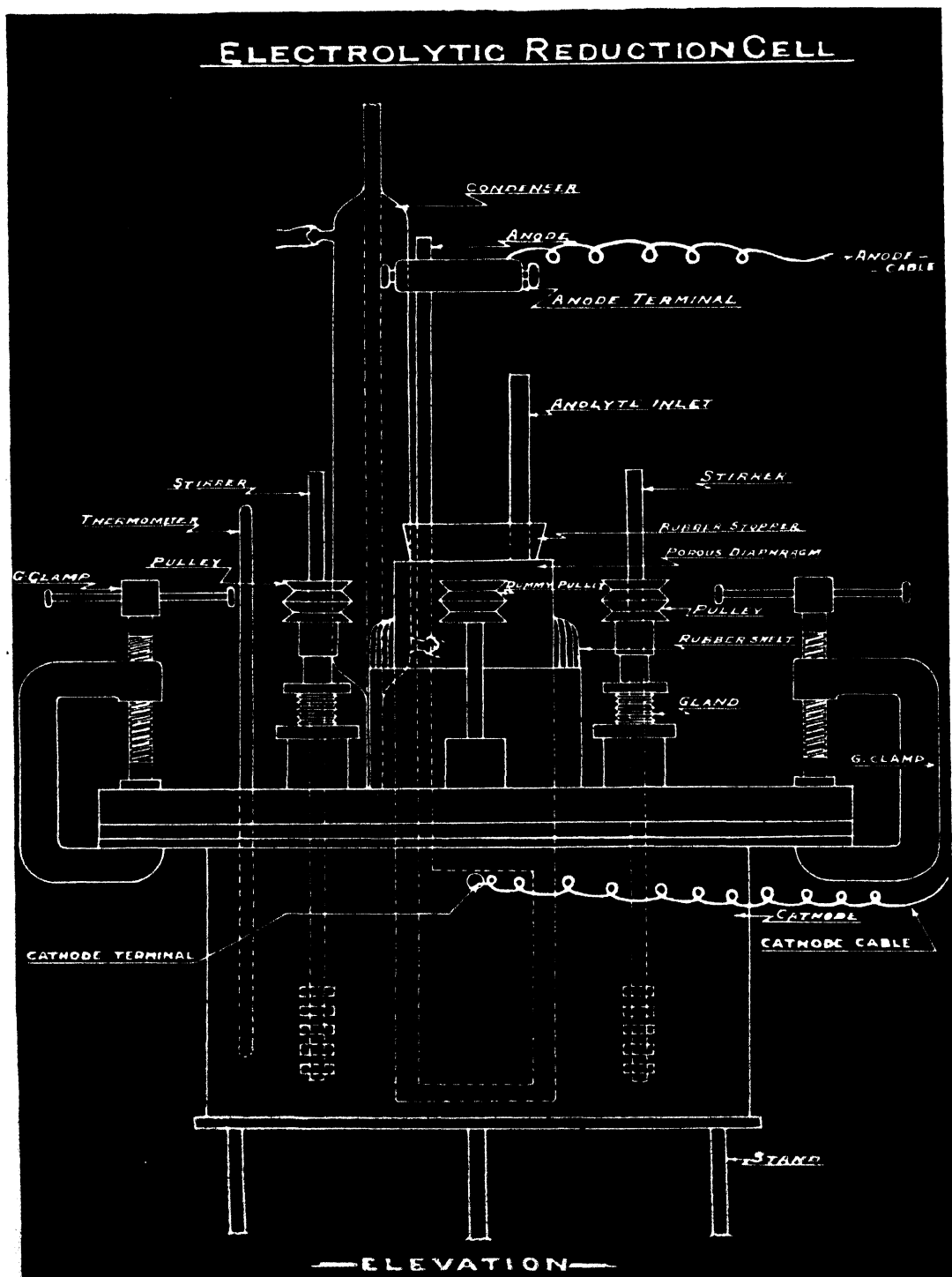


Fig. 1.

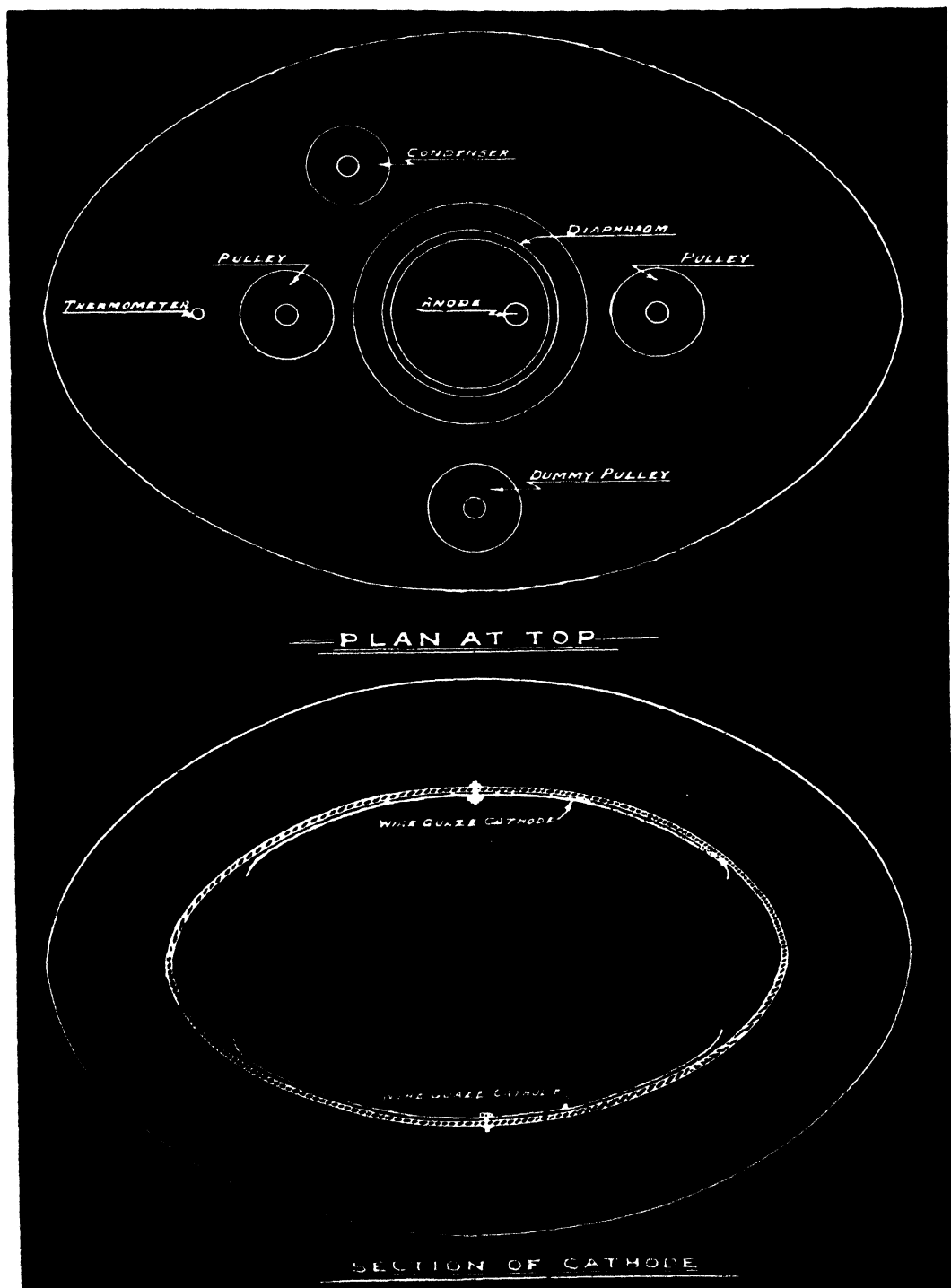


Fig. 1a.

TABLE II. Preliminary Experiments on the Reduction of Nitrobenzene in Alkaline Emulsion.

No.	Nitrobenzene gms.	Sodium hydroxide soln.		Total current amp. hrs.	Apparent current density amp./sq. dm.	Hydrazo- benzene gms.	Yield %	Azo- benzene gms.	Yield %	PbO added gms.
		Volume cc.	Strength %							
1	150	900	3	185.0	<i>Monel cathode</i> 3.0	53	48	35	32	Nil.
2	150	900	4	185.0	4.0	85	77	11	10	15
3	150	900	4	183.6	4.0	88	80	6	5	25
4	800	4,000	10	1,013.0	1.5	530	88	50	8	100
5	400	2,000	4	465.0	<i>Lead cathode</i> 1.0	266	88	20	6	Nil.
6	400	2,000	10	500.0	1.5	270	90	15	5	Nil.
7	400	2,000	10	465.0	<i>Iron cathode</i> 1.5	276	92	11	3.5	50
8	400	2,000	10	502.0	1.5	275	91.9	13	4	(continuing from the last expt. without PbO.)

screw type with asbestos packing. There was a third pivot placed at one end of the shorter axis of the lid, which served for the play of a dummy pulley, whose purpose was to lessen the strain on the stirrer pulleys and to prevent the driving belt passing over the centre of the vessel and interfering with the diaphragm, anode leads, etc. At the centre of the vessel there was a circular hole 2.5" in diameter which was surrounded by a wall, 0.25" thick projecting 1" on the top side and 0.5" on the bottom side. The diaphragm could be passed through this guide into the vessel with a clearance of 0.25". The escape of vapours through this gap was prevented by tying up the portion of the diaphragm projecting outside the vessel and the guide with a thin rubber sheet. The lid was provided with a hole for introducing a thermometer and another for a condenser. The stirrers were run at approximately 2,000 revolutions per minute in all the reductions, which were all conducted at 80° C. When filled up with 400 cc. of alkali and 100 gms. of nitro-compound the effective cathode surface was 10.0 sq. dm. When an extra 200 cc. of xylene were added the effective cathode surface was 13.5 sq. dm.

A typical reduction was conducted as follows: The alkali of the specified strength was heated up to boiling with the addition agent for dissolving and introduced into the cell. The porous diaphragm was also filled up to the same level (100 cc.) with 30 per cent. alkali. The current was passed at 20 amperes, for about 15 minutes with heating and when the temperature had reached 80° C., the nitro-compound was added. The reduction was carried out at the specified amperage, keeping the temperature at 80° C. When 90 per cent. of the theoretical current

had been passed, 200 cc. of xylene were added and the reduction continued till the solvent layer was just colourless. In some cases (Expts. 1, 15, 17, 19 and 20, Table III) the colour was not completely discharged and the reduction was stopped when a constant shade of colour had been obtained. The alkali and xylene layers were withdrawn from the cell, separated and any free alkali in the xylene layer neutralized by passing carbon dioxide. The xylene layer was then poured into acid for benzidine transformation. When 100 gms. of nitrobenzene had been taken, the transformation was effected by pouring into 80 cc. of of HCl (d, 1.16) and 150 gms. ice, stirring for 5 hours in the cold and raising the temperature during the sixth hour to gentle boiling. The pasty mass was then filtered and the residue washed with xylene to free it from azobenzene. The filtrate consisted of two layers, the aqueous layer containing benzidine hydrochloride and the xylene layer azobenzene. The residue consisting of benzidine hydrochloride was dissolved in the aqueous layer and the benzidine precipitated as the insoluble sulphate by addition of the calculated amount of dilute sulphuric acid. The benzidine sulphate was filtered, dried and weighed. The acid filtrate from this was basified, steam distilled to remove aniline and the aniline estimated by the bromide-bromate method. The azobenzene was recovered from the xylene layer by blowing in steam and removing the xylene.

The results obtained in this study are given in Table III.

In interpreting the results, some important points must be borne in mind.

- (1) The factors capable of influencing the course of electrolytic processes are

TABLE III. Electrolytic Reduction of Nitrobenzene in Sodium Hydroxide Emulsion at Iron Cathode, at 80° C.

No.	Nitro benzene gms.	Catholyte		Catalyst		Current			Benzidine sulphate gms.	Yield %	Azo-benzene gms.	Yield %	Aniline gms.	Yield %
		Strength %	Volume cc.	Used	Amount gms.	Strength amps.	Density (apparent) amps. sq. dm.	Total amp. hrs.						
1	100	10	400	Nil.	10	20	2	175	7	6.1	53	11.6	12.9	17.1
2	100	10	400	PbO	10	10	1	129	100	87.2	2	2.7	2.9	3.8
3	100	10	400	PbO	10	20	2	135	95	82.9	2	2.7	4.5	5.9
4	100	10	400	PbO	10	30	3	140	97	84.6	3	4.1	4.8	6.3
5	100	10	400	PbO	10	40	4	160	89	77.6	1	1.4	2.3	3.0
6	100	10	400	PbO	10	50	5	179	97	84.6	5	6.8	5.9	7.8
7	100	10	400	PbO	10	50*	5	129	90	78.5	3	4.1	5.7	7.5
8	100	10	400	PbO	20	20	2	130	89	77.6	2	2.7	2.7	3.5
9	100	10	400	PbO	30	20	2	122	92	80.3	2	2.7	3.2	4.2
10	100	20	400	PbO	10	20	2	130	97	84.6	3	4.1	5.1	6.7
11	100	30	400	PbO	10	20	2	145	105	91.6	2	2.7	4.8	6.3
12	96.6	10	403	PbO	10	20	2	120	85	76.8	1	1.4	5.8	7.9
13	116.6	10	387	PbO	10	20	2	160	120	90.2	2	1.9	4.4	5.0
14	145.2	10	362	PbO	10	20	2	187	151	90.7	2	3.3	3.3	3.1
15	100	10	400	V ₂ O ₅	5	20	2	170	82	71.5	20	27.0	2.9	3.8
16	100	10	400	PbO & V ₂ O ₅	10	20	2	160	100	87.2	4	5.4	3.95	5.2
17	100	10	400	Ce(SO ₄) ₂	5	20	2	171	72	62.8	22	29.7	5.9	7.8
18	100	10	400	PbO & Ce(SO ₄) ₂	10	20	2	142	97	84.6	7	9.5	5.2	6.9
19	100	10	400	ZnO	20	20	2	160	53	46.2	23	31.1		
20	100	10	400	SnO	10	20	2	140	37	32.3	22	27.3	12.0	15.9

* Reduction at 50 amps. till azoxy stage and at 10 amps. thereafter. (azoxy)

* Reduction at 30 amps. till azoxy stage and at 10 amps. thereafter.

numerous and in a study of this type where one factor is allowed to vary, the reproduction of all other factors to the smallest detail is attended with great difficulties.

- (2) Hydrazobenzene can be estimated iodimetrically³⁰, but under the conditions employed in the study, when the products are removed by xylene, the difficulty of employing this method will be readily appreciated. Isolation of hydrazobenzene in each experiment would involve not only time and labour, but also losses due to re-oxidation and reductive cleavage³¹. The efficiency of the reduction was, therefore, assessed from the weight of benzidine sulphate obtained from the hydrazobenzene in each reduction. It is obvious that this procedure will introduce another source of variation. The generalizations should, therefore, be made on a broad basis and a rigid interpretation based on a variation of a few per cent. on either side will be misleading.

Influence of Current Density.—Since satisfactory yields of hydrazobenzene were obtained only by the addition of lead oxide, all the experiments on the influence of current density were conducted only after the addition of this compound. The lead oxide was first dissolved in the catholyte forming sodium plumbite. On passing the current, lead was deposited on the cathode in a spongy state. Since it was not possible to compute the exact surface offered by the spongy lead, only the surface offered by the cathode was taken into account. In any case, it can be assumed that the surface offered by the spongy lead will be a constant factor in all the experiments, provided the same amount of lead oxide had been added. Thus in a reduction conducted at 20 amps., the iron cathode surface being 10 sq. dm., the current density has been given as 2 amps./sq. dm. without taking into account the surface offered by the lead sponge. The effective current density will be really less than the apparent value of 2 amps./sq.dm.

Influence of Concentration of Alkali.—Current efficiency is not appreciably affected by increasing the alkali strength. There is a definite improvement in the material yield.

Influence of Concentration of Depolariser.—There is no marked improvement in current efficiency by increase of depolariser concen-

tration. Material yield is, however, definitely improved by increase of depolariser concentration. On the technical scale the increased cell voltage due to increase of depolariser concentration may be a disadvantage.

Influence of Added Compounds.—Lead oxide is the most valuable addition agent. It dissolves in the alkali forming sodium plumbite, and on passing current, is deposited on the cathode surface as spongy lead. At the end of the reduction, lead is completely absent in the alkali layer. In technical operation, after completion of one reduction and withdrawal of the charge, a fresh charge can be added and the reduction continued without addition of any fresh amount of lead oxide, since the spongy lead from the previous reduction is almost completely retained in the cathode chamber. Increasing the amount of lead oxide does not have much influence either in increasing the material yield or the current efficiency.

The results obtained have clearly proved that the claims advanced in some patents about the efficacy of zinc and tin oxides as addition agents are false.

The addition of vanadium pentoxide and ceric sulphate carries the reduction farther than with an iron cathode alone, but the results are not satisfactory. In combination with lead oxide, the yields obtained with vanadium pentoxide or ceric sulphate are only about the same as with lead oxide alone. The current efficiency is, however, definitely lowered by addition of these compounds.

The reason for increased formation of hydrazo compound by the addition of lead oxide seems to be due to the increased over-voltage when the metal is deposited on the cathode. In addition, because of the large surface offered by the lead sponge, more intimate contact between the cathode and depolariser is favoured, so that rapid reduction can occur.

Conclusion

From the experimental data presented above, it has been proved unmistakably that electrolytic reduction of nitrobenzene in alkaline emulsion at an iron cathode is superior to all other methods for the production of benzidine and is best suited for adoption on the industrial scale. The yield of benzidine obtained is nearly 90 per cent. of the theoretical and is about equal to that obtained by Fierz David by chemical

method³² or that obtained in reduction with sodium amalgam²⁴ or that claimed for the electrolytic method stated³³ to be in operation in Switzerland.

The process has been operated on a pilot plant scale handling 20 to 30 lbs. of nitrobenzene in one charge. The results obtained with this plant will form the subject of a further communication.

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References

- ¹ Zinin, *J. Prakt. Chem.*, 1845, **36**, 93.
- ² Bottiger, *D.R.P.* 28753 (1884) *E.P.* 4415 (1884).
- ³ Teichmann, *Z. angew. Chem.*, 1893, **6**, 67; Erdmann, *ibid.* 1893, **6**, 163; Griesheim Elektron, *D.R.P.*, 288,413.
- ⁴ Weiler-ter-Meer, *D.R.P.* 140,613 (1900).
- ⁵ Fierz David, *Fundamental Operations of Dye Chemistry*, (1927) 61.
- ⁶ Lidbury, *Chem. and Met. Eng.*, 1915, **13**, 211.
- ⁷ Haussermann, *Chem. Zeit.*, 1893, **17**, 129, 209.
- ⁸ Straub, *D.R.P.* 79731 (1894).
- ⁹ Wulff, *D.R.P.* 110, 234 (1898).
- ¹⁰ Glasstone and Hickling, *Electrolytic Oxidation and Reduction* (1935) 194.
- ¹¹ Elbs, *Chem. Zeit.*, 1893, **17**, 209.
- ¹² Löb, *D.R.P.* 116467 (1900).
- ¹³ Meister, Lucius and Brünig, *D.R.P.* 127727 (1900).
- ¹⁴ *Ibid.*, *D.R.P.* 172654 (1903).
- ¹⁵ *Ibid.*, *D.R.P.* 168273 (1903).
- ¹⁶ Boehringer and Söhne, *D.R.P.* 117007 (1900); Thatcher, *A.P.* 1544357 (1923).
- ¹⁷ Engelhardt, *Handbuch der technischen Electrochemie*, 1933, Band II, Teil II, 254.
- ¹⁸ Bayer & Co., *D.R.P.*, 121899 (1900).
- ¹⁹ Darmstädter, *D.R.P.*, 181116 (1904).
- ²⁰ Brunner, *Sch. P.* 87885; *E.P.* 147541 (1920).
- ²¹ Moldenhäuer, *D.R.P.*, 264013 (1912).
- ²² Gesellschaft für Chemische Industrie, *D.R.P.*, 297,019 (1917).
- ²³ Discussion, *Trans. Amer. Elec. Chem. Soc.*, 1924, **45**, 105.
- ²⁴ Poma and Pellegrini, *D.R.P.* 410180 (1921); Friedlander, *Teer Farben Fabrikation*, 1925-27, **15**, 216.
- ²⁵ McKee and Lloyd, *Dissertation, Columbia University*, 1930.
- ²⁶ McKee and Heard, *Trans. Amer. Elec. Chem. Soc.*, 1934, **65**, 135, 161.
- ²⁷ McKee and Brockman, *ibid.*, 1932, **62**, 203.
- ²⁸ McKee and Gerapostolou, *ibid.*, 1935, **68**, 329.
- ²⁹ Elbs, *Electrolytic Preparations*, 1903, 82.
- ³⁰ Stieglitz and Curme, *Ber.*, 1913, **46**, 911; Curme, *J.A.C.S.*, 1913, **35**, 11.
- ³¹ Izmailski and Rustanovich, *Anilinokrasnochaya, Prom.*, 1932, **3**, 10; Izmailski and Arbuzov, *J. Chem. Ind. (Russia)*, 1925, **5-6**, 35.
- ³² Fierz David, *Fundamental Operations of Dye Chemistry*, 1927, 60.
- ³³ Fichter, *Congr. intern. elec., Paris, Sect. I, Rapport*, No. 19, 1932, 6; *Science Abstracts*, **55B**, 706.

PART II—THE ELECTROLYTIC PRODUCTION OF BENZIDINE

IN Part I of this series¹, a detailed account of the experimental work carried out on the production of benzidine by three selected electrolytic methods was given. The results obtained proved clearly that the reduction of nitrobenzene in alkaline emulsion was the best for the purpose, leading to hydrazobenzene of high purity in the maximum yield. By this procedure, it was possible to operate the electrolytic cell at a low voltage, save the cost of solvent which is an important factor in large-scale production and also avoid the contamination of the reduction product by undesirable impurities.

It is a common charge against electrolytic methods, particularly those for the production of organic compounds, that while they are capable of yielding excellent results on the laboratory scale, their suitability for technical production is doubtful, the chief disadvantages being low space-time yield, necessity for expert supervision and severity of operating conditions. The small-scale experiments carried out on the reduction of nitrobenzene in alkaline emulsion were of great value in assessing the influence of factors like current density, concentration of alkali and depolarizer and of addition agents and in determining the optimum conditions. It would not be proper, however, to recommend the process for adoption on the industrial scale or to calculate the cost of production, from the results obtained in the small-scale experiments. A study of the process on a pilot plant scale was, therefore, imperative before the suitability of the process for industrial production and the claims made about the cost of production could be conceded.

The studies on the large-scale production of benzidine described in this paper were carried out first in a cell handling 2 kg. of nitrobenzene, with a cathode surface of 40 sq. dm. and operated at 100 amps. and then in a cell handling 10 kg. of nitrobenzene with cathode surface of 200 sq. dm. and operated at 450 amps.

As in the small-scale experiments, the vessel of sheet iron itself served as the cathode chamber. Due to the difficulty of getting iron gauze, additional cathode surface was provided by a set of sheet iron vanes. An oval vessel was preferred to ensure a more uniform distribution of current.

Instead of using a single anode set in a large central cylindrical diaphragm, three anodes in three smaller cylindrical diaphragms arranged along the longer axis of the vessel were employed. This was helpful in distributing the current evenly, avoiding overheating and in lowering the bath voltage. The design was based mainly on the type B-5 cells described by McKee and Gera-postolou², with necessary modifications to suit reduction in alkaline emulsion.

The hydrazobenzene formed in the reduction was removed by xylene as in the small-scale experiments and immediately converted to benzidine by treatment with mineral acid. The yield of benzidine sulphate was the same whether the conversion was accomplished direct with sulphuric acid or whether the sulphate was precipitated from the benzidine hydrochloride solution obtained by carrying out the conversion with hydrochloric acid.

The isolation of benzidine as the sulphate is essential for obtaining benzidine of purity, free from aniline or diphenylene whose sulphates are soluble in water and easily removable by washing the insoluble benzidine sulphate with water. Hence the use of sulphuric acid instead of hydrochloric acid eliminates one additional step in the production of benzidine and saves the cost of hydrochloric acid.

The only disadvantage of using sulphuric acid was that the pasty mass of benzidine sulphate, xylene and dilute sulphuric acid is difficult to filter. The use of a vacuum filter of the Buchner type was impracticable due to the extremely slow filtration rate. Centrifugal filtration was fairly rapid, but there was loss of xylene due to evaporation. A filter press would have been ideal for the purpose but was not available for this investigation. The major trouble encountered in the pilot plant experiments described in this paper was the filtration of benzidine sulphate, but with modern filtering equipment designed to suit every special need, this will not be an obstacle in the large-scale production of benzidine. The benzidine sulphate precipitated from the hydrochloride solution was, however, easily filterable. As regards the electrolytic process itself, the large cell was operated with the same ease and smoothness as the small cell. No undesirable heating

effects were noticed even with the large current and the cell was maintained at 80° C. quite easily by regulating the flow of water in the jacket. The only attention needed was to withdraw the weakened anolyte at intervals of about six hours, fortify it to 20 to 25 per cent. and return it to the anode chambers, a process which required only a few minutes each time. In an industrial cell, this operation may quite easily be made automatic by the regulated addition of solid caustic soda so that there need be no interruption during the reduction.

The weakest points in the large cell were the diaphragms which were of china-clay. Unless certain precautions were taken, these became valueless by blocking of pores or by cracking. By using alkali of less than 25 per cent. strength and charging the anolyte after heating it to the same temperature as the discharged anolyte, the diaphragms were found to give reasonably good service. Diaphragms of china-clay may not, however, be suitable for industrial operations, being incapable of standing up to the continuous action of hot alkali. They had to be employed in these studies due to the non-availability of other kinds of diaphragm material at the time the investigations were carried out. Alundum diaphragms of the dense type would have been ideal for the purpose, since they are resistant to the action of alkali, have a low temperature coefficient and a low resistance. In tests carried out with small alundum diaphragms, excellent results were obtained and they were found to be superior in every respect to the china-clay diaphragms.

A comparison of the results obtained in the small and large-scale experiments is given below.

The catholyte increases in strength from 10 per cent. at the beginning to nearly 20 per cent. at the end of the reduction. After removal of hydrazobenzene by xylene, sufficient amount of this 20 per cent. alkali

was taken and made up to 10 per cent. for use in the subsequent reduction. The 20 per cent. alkali left over (nearly 50 per cent.) was utilized for charging the anode chamber. The same procedure was adopted in the subsequent reductions.

At the end of the reduction, no lead was found in solution, the entire amount being left in a spongy state adhering to the sides and bottom of the vessel and to the vanes. It is, therefore, unnecessary to add further amounts of lead oxide except 5 to 10 per cent. to make up for the mechanical losses at the time of discharging the cell. Traces of zinc, copper or tin, if introduced into the cell, completely inhibit reduction beyond the azobenzene stage. Hence great care is necessary in making up the solutions and in operating the cell to avoid contamination of the cell with undesirable impurities.

In industrial electro-organic reductions, the unit cells are rarely operated at more than 1,000 amps. and large amounts are handled by multiplying such units, each carrying not more than 1,000 amps. and increasing the duration of reduction as required. The pilot plant operated at 450 amps. can, therefore, furnish a fairly accurate idea of the operational features of the industrial cell. It is seen that the results obtained in the small-scale experiments are reproducible on the pilot plant scale both with regard to current and material yields. The process of electrolytic reduction of nitrobenzene in alkaline emulsion can, therefore, be considered technically sound and suitable for adoption on the industrial scale.

It would be of interest to have an approximate idea of the cost of production of benzidine prepared by this method. Since charges of supervision, overhead, interest and depreciation, etc., will depend to a large extent on the scale of production, whether this is to be the sole product or one of several allied products, and the location of the

No.	Nitro-benzene gms.	Lead oxide gms.	Vol. of alkali cc.	Current			Cell Voltage volts	Benzidine sulphate	
				Strength amps.	Density amps./sq. dm.	Total amp. hrs.		Yield gms.	Yield %
1.	100	10	400	20	2	135	4.0—4.5	95	82.9
2.	2,000	200	8,000	100	2.5	2,400	3.5—4.5	1,750	76.3
3	12,500	900	60,000	400 to 450	2.0 to 2.25	14,353	3.5—4.5	11,228	78.4
4	10,000 and 3,640 Azobenzene	900	40,000	400 to 450	2.0 to 2.25	14,810	3.5—4.5	13,060	76.3
5	10,000	900	40,000	400 to 450	2.0 to 2.25	12,966	3.5—4.5	9,037	78.8

All the reductions were carried out in 10 per cent. alkali (NaOH) at 80° C.

factory, no attempt has been made to calculate the charges under these heads.

The attempt has been confined to calculating the material and power charges. This has been done—(a) on the basis of the present prices in India and (b) the pre-war prices in the United Kingdom.

Cost of production of Nitrobenzene.—This has been calculated according to the data presented by Groggins¹.

Materials to produce 100 lbs. of Nitrobenzene
(a) *Present Indian Prices.*

	Annas
65.15 lbs. benzene	265.9
202.6 lbs. sulphuric acid	433.6
85.23 lbs. nitric acid (1.4-d) ..	767.07
1.0 lb. soda ash	1.85
Total material cost for 100 lbs. of nitrobenzene	1,468.42
	Annas
Operating cost, power cost, overhead, etc.—15/85 of 1468.42	259.1
Total cost for 100 lbs. of nitrobenzene	1,727.52
1 lb. of nitrobenzene	17.28
(b) <i>Pre-war price in the U.K.</i>	d.
65.15 lbs. benzene	151.1
71.00 lbs. sulphuric acid	34.8
55.00 lbs. nitric acid (d-1.52) ..	106.2
1 lb. soda ash	0.83
Total material cost for 100 lbs. of nitrobenzene	292.93
Operating cost, power cost, overhead, etc.—15/85 of 292.93	51.69
Total cost for 100 lbs. of nitrobenzene	344.62
Cost per 1 lb. of nitrobenzene ..	3.45
(The waste acid is not worked up for sulphuric acid and nitric acid)	

Cost of production of Benzidine
Materials to produce 13.23 lbs. of benzidine.

	(a) Annas	(b) d.
Nitrobenzene, 22.05 lbs.	381	76.07
Sodium hydroxide, 26.45 lbs.	75.37	33.6
Hydrochloric acid, 22.05 lbs.	94.36	14.1
Lead oxide, 2.21 lbs.	5.3	6.0
Sulphuric acid, 6.63 lbs.	14.19	3.2
Solvent, 5 gallons	180.0	80.0
Soda ash, 7.94 lbs.	14.69	6.0
Material cost	892.62	219.57
<i>Credits.</i> —95 per cent. of sodium hydroxide, catalyst and solvent are recoverable	247.7	113.9
Net material cost for 13.23 lbs. of benzidine	644.92	92.4
Assuming that power charges are same in both (a) and (b),	Annas	d.
Cost of current, 70 kw. hrs., allowing for 80 per cent. efficiency of conversion of a.c. to d.c. by generator, at 9 pies per kw. hr.	52.5	59.6
Total material and power cost for 13.23 lbs. of benzidine	697.42	152.0
Total material and power cost for 1 lb. of benzidine	52.7	11.49

Raw material	Present Indian price (a)	Pre-war price in U.K.* (b)
Benzene	Rs. 2-4 per gallon As. 4.08 per lb.	1s. 8½d. per gallon 2.32d. per lb.
Sulphuric acid	Rs. 15-0 per cwt. As. 2.14 per lb.	£4-12 per ton 0.49d. per lb.
Hydrochloric acid	Rs. 30-0 per cwt. As. 4.28 per lb.	0.83d. per lb.
Nitric acid	Rs. 63-0 per cwt. (d-1.4) As. 9.0 per lb.	£18-0 per ton (d-1.52) 1.93d. per lb.
Caustic soda	Rs. 20-0 per cwt. As. 2.85 per lb.	£12-10 per ton 1.27d. per lb.
Soda ash	Rs. 13 per cwt. As. 1.85 per lb.	£5-17-6 per ton 0.83d. per lb.
Xylene	Rs. 2-4 per gallon	£0-1-4 per gallon

(*Chemical Trade J., Dec. 1938.)

Thus 1 lb. of benzidine prepared by this method costs according to present Indian prices Rs. 3-4-9 and according to pre-war U.K. prices 11.49*d.* per lb. As stated earlier, these figures do not include charges for supervision, overhead, interest and depreciation. The market price of benzidine in 1938 was 2*s.* 6*d.* per lb. in U.K.

Experimental

The reduction handling 2 kg. of nitrobenzene was carried out in an oval sheet iron vessel whose axes were 14" by 12" and 12" high, and provided with a jacket for circulation of steam or cold water. Additional cathode surface was provided by a set of 10 sheet iron vanes 3" by 5", attached to two oval iron rings, 12" by 10" and 5" apart. The effective cathode surface when the vessel was filled with 8 litres of alkali and 2 kg. of nitrobenzene was 40 sq. dm.

The diaphragms (three in number) were cylindrical porous pots of china-clay, 13" high and 2.5" diameter, resting on a shelf 0.5" above the bottom of the vessel and projecting 1.5" above the lid through three guide tubes 3" diameter and 1" length welded to the lid. The gaps between the guide tubes and the diaphragms were closed by tying up with rubber sheets. The lid also had two bearings for the operation of two stirrers whose blades were 2" wide. The stirrers were driven by a belt and pulley arrangement by a 0.1 h.p. motor. The anodes were of monel.

The large cell was modelled on the above cell. It consisted of an autogenously welded sheet iron vessel of oval shape, whose axes were 24" by 18" and 18" high, provided with a jacket. The cathode area was increased by a set of 50 sheet iron vanes 12" by 3" and 15" high, arranged in such a way that the maximum amount of space was available inside the vessel. The anodes were of monel sheet (16" high, 4" in diameter) inside three cylindrical porous pots of china-clay 22" high and 5" diameter. The lid was provided with guide tubes for the porous pots and bearings for the stirrers which were driven by a $\frac{1}{2}$ h.p. motor by a belt and pulley arrangement. A detailed description of the cell can be had by referring to the scale diagram (Fig. I).

The current was supplied by two generators, with an output of 350 amps. and 100 amps. at 6 volts.

The reduction was conducted as follows:—The anode chambers were filled to the required level with 20 per cent. alkali. Forty litres of 10 per cent. alkali were then introduced into the cathode chamber and 900 gms. of lead oxide were added with stirring. The cell was heated up to 80° C., passing current at 100 amps. 10 kgs. of nitrobenzene were then introduced and the current increased to 450 amps. Ammeter readings were taken at frequent intervals and the current maintained at the required strength by the shunt regulators. When the cell voltage tended to rise, due to dilution of anolyte (once in about six hours) the anolyte was withdrawn and 20 per cent. alkali heated to 80° C. was introduced into the anode chambers. When 10,000 amp. hrs. had been passed, 20 litres of xylene were added and the reduction continued till the xylene layer became colourless.

The stirrers were then stopped and a low current (10 amps.) was passed. The alkali layer was first drawn off through the discharge cock at the bottom and then the xylene layer. There was no emulsion formation, and the separation of the layers was complete and offered no difficulty.

The xylene layer containing the hydrazobenzene was then run into ice and acid contained in a jacketed, lead-lined vessel of 100 litres capacity provided with an anchor type stirrer, charging hole and condenser.

In experiment (3), the conversion was effected by running the xylene solution into 3,210 c.c. of sulphuric acid, 6,790 cc. of water and 50 lbs. ice.

In experiment (4), 3,770 cc. of sulphuric acid, 6,280 c.c. of water and 50 lbs. of ice were employed.

In experiment (5), 8,960 cc. of conc. HCl (*d*-1.16) and 50 lbs. ice were employed. The sulphate was precipitated by adding to the aqueous layer, after separating the xylene, 6.63 lbs. of sulphuric acid diluted to 15 litres.

In experiment (2), the hydrazobenzene was removed in 4 litres of xylene and the conversion effected in a smaller lead-lined vessel of 20 litres capacity by adding to 1,900 cc. of conc. hydrochloric acid and 10 lbs. ice.

In all cases, the mass was stirred in the cold for five hours and the temperature

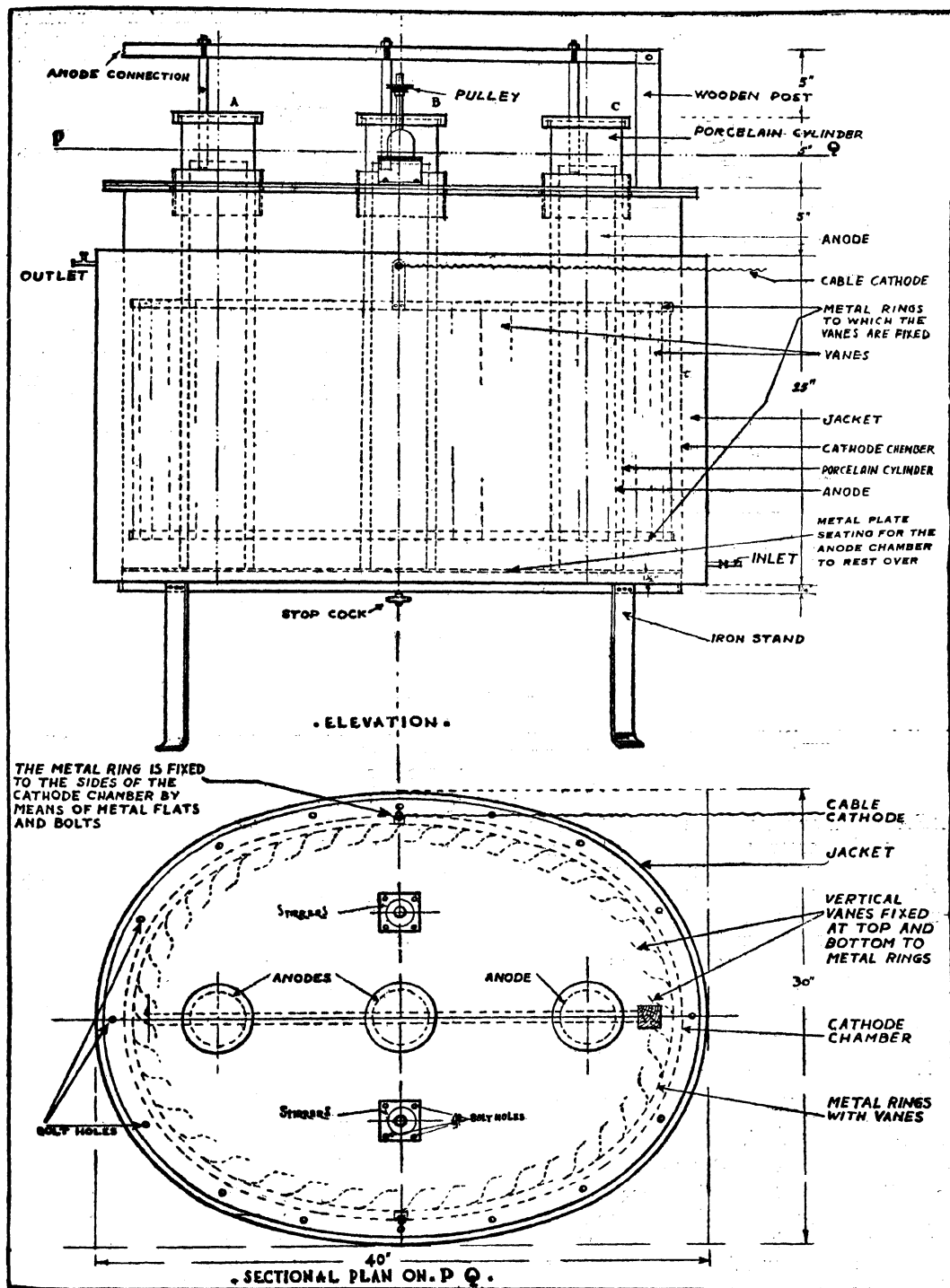


Fig. 1.

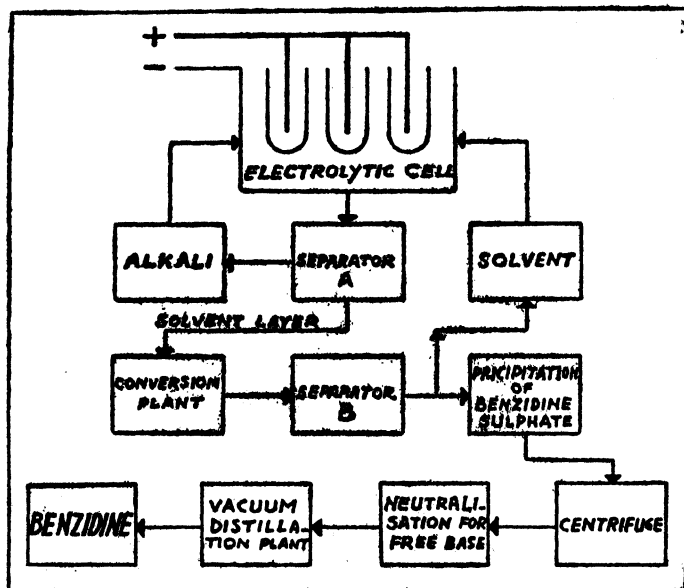


Fig. 2. Flow-sheet for Benzidine.

raised in the sixth hour to about 90° C., when the xylene-water mixture started refluxing vigorously.

After filtration, the benzidine sulphate was washed with water and dried in a vacuum drier. The free base was prepared when necessary, by suspending the moist sulphate in water and basifying with sodium carbonate solution.

The experimental procedure involved in the preparation of benzidine by this method is illustrated in the flow-sheet. (Figure II).

Our grateful thanks are due to the Council of Scientific and Industrial Research, for meeting the entire expenses of this investigation and for kind permission to publish the results.

References

- ¹ Dey, Govindachari and Rajagopalan, *J. Sci. and Ind. Res.*, 1946, 4, 559.
- ² McKee and Gerapostolou, *Trans. Amer. Elec. Chem. Soc.*, 1935, 68, 329.
- ³ Groggins, *Unit Processes in Organic Synthesis*, 1935, p. 36.

PART III—THE ELECTROLYTIC REDUCTION OF NITROBENZENE TO *PARA* AMINOPHENOL

PARA aminophenol is a compound of great importance in the field of dyestuffs, pharmaceuticals and photographic developers. Under the name *Ursol P*, it has been employed for dyeing fur and hair a deep shade of brown. Under the names *Rodinal*, *Kodinal*, *Paranol*, *Citol*, *Azol*, etc., concentrated solutions of *para* aminophenol are employed as developers, which are rapid and soft-working and suitable for use in tropical climates. *Para* aminophenol also serves as an intermediate for the production of other important photographic developers like *Metol*, *Glycine*, *Duritol*, etc. *Para* aminophenol is employed in large quantities for the production specially of sulphur colours like *Immedial Black*, *Pyrogene Direct Blue*, etc. When available at economical prices *para* aminophenol can also be employed for the production of the drugs phenacetin and methacetin.

On the technical scale, *para* aminophenol is being made both by chemical and electro-

chemical methods. Of the chemical methods, the most important are:

- (1) Reduction of *para* nitrophenol with iron and hydrochloric acid¹; tin and hydrochloric acid or sodium sulphide².
- (2) Reduction of *para* nitrosophenol with sodium sulphide^{2,3}.
- (3) Reduction of *para* azophenol⁴ with stannous chloride or zinc and sodium hydroxide, and
- (4) Heating *para* chlorophenol⁵ with ammonium hydroxide in the presence of copper salts.

In all these cases, the intermediates like *para* nitrophenol or *para* azophenol have themselves to be made by a series of operations from the coal-tar primaries like benzene.

Electrolytically, *para* aminophenol can be made either by the reduction of *para* nitro-

phenol or of nitrobenzene. However, the electrolytic reduction of nitrobenzene is technically more significant for the reason that *para* nitrophenol is nearly ten times as costly as nitrobenzene and even with lower yields, the reduction of nitrobenzene would be more economical.

The advantages of the electrolytic over the chemical method have been enumerated in previous communications⁶, and in the case of *para* aminophenol the advantage is reinforced by the electrolytic method requiring a cheap starting material, viz., nitrobenzene.

Gattermann⁷ was the first to describe the electrolytic preparation of *para* aminophenol from nitrobenzene. By reducing nitrobenzene in a warm concentrated solution of sulphuric acid containing a little water, at a smooth platinum cathode, he obtained *para* aminophenol in 20 to 50 per cent. yield. Noyes and Clement⁸ obtained only *para* aminophenol sulphonic acid by electrolysis in sulphuric acid of *d* 1.84-1.94. Darmstadter⁹ substituted carbon cathodes for the platinum in Gattermann's experiment and claimed a yield of 80 per cent. Similar high yields were claimed by Thatcher¹⁰ who also used carbon cathodes and concentrated sulphuric acid. Caesar¹¹ obtained *para* aminophenol in a material yield of 41 per cent. and current yield of 39.1 per cent. by employing a copper gauze cathode and duriron anode in a cell similar to that described by Elbs¹² for operating the Gattermann method. During the war of 1914-18, several tons of *para* aminophenol were manufactured by Thatcher's method and also by a modified Gattermann procedure adopted by Eastman Kodak. A detailed description of the latter method is furnished by McDaniel, Schneider and Ballard¹³. The production was carried out in a set of forty cells arranged in banks of ten, in a brine tank. Each cell was provided with a thin porous diaphragm of china-clay. The catholyte was a 91 per cent. solution of sulphuric acid and the anolyte sulphuric acid of *d* 1.75. 650 gms. of nitrobenzene in 1800 cc. of 91 per cent. sulphuric acid was placed in the cathode chamber and the reduction was conducted at 60 amps. for 24 hours, the cell voltage being 8 volts and the temperature below 30° C. Each cell yielded 226-280 gms. of *para* aminophenol, the current yield being 25 per cent., the chemical yield 40-50 per cent. and the yield per kw. hr. 40-50 gms. McDaniel *et al.* found

that graphite and carbon cathodes gave poor results and platinum was the only metal which gave good yields. Although the method was operated for some years, it was abandoned in favour of the chemical method, the main reasons being high labour charges, difficulty of recovering sulphuric acid which is a very heavy item in the costs and excessive upkeep charges due to the corrosion of the equipment. In addition, the use of platinum electrodes makes this process technically difficult, especially for this country. The Kodak method is one of the rare instances where full data of a technically operated process have been made available and it has, therefore, been described at some length for purposes of comparison with the method arrived at in this laboratory.

The rigour of the operating conditions in the Gattermann procedure was sought to be lessened by the use of less concentrated sulphuric acid. The nitrobenzene is kept in a state of emulsion in the dilute sulphuric acid by vigorous stirring. Darmstadter claims a yield of 80 per cent. and more by employing porous carbon electrodes¹⁴ and electrolysis in an emulsion with 50 per cent. sulphuric acid. This claim is substantiated by Burwell¹⁵, Shoji¹⁶, by employing sulphuric acid of not more than 80 per cent. strength and stirring, at a platinum cathode obtained aminophenol in 43 per cent. yield. Brigham and Lukens¹⁷ worked out the optimum conditions for reduction at a nickel cathode with 50 per cent. sulphuric acid and obtained aminophenol in a material yield of 64 per cent. and current yield of 62.2 per cent.

Although some of these procedures may be improvements on Gattermann's method, the employment of fairly strong sulphuric acid is a serious handicap for operation on a technical scale. Sulphuric acid becomes a heavy item in the costs and the corrosive action on the electrodes and other equipment is bound to be considerable. Carbon cathodes may perhaps not be attacked much, but conflicting yields have been reported for reductions carried out at this electrode. Platinum electrodes will entail heavy capital costs and require expert supervision for proper conservation.

The advantages of using fairly dilute sulphuric acid as the electrolyte with cheap materials like copper, lead, nickel, monel, etc., as the electrodes is, therefore, obvious for the electrolytic process to be technically

feasible. The mechanism of the formation of aminophenol by the electrolytic reduction of nitrobenzene is well understood. The β phenyl hydroxylamine molecule formed initially by the reduction of nitrobenzene rearranges¹⁸ itself in the presence of acid to *para* aminophenol. β phenyl hydroxylamine is also a good depolarizer and can be further reduced to aniline, at the cathode. The amounts of aniline and *para* aminophenol will, therefore, depend on the relative speed of rearrangement of the phenyl hydroxylamine molecule and of its reduction to aniline. If, therefore, the speed of reduction of phenyl hydroxylamine could be reduced, higher yields of *para* aminophenol can be expected. It has been suggested that this can be accomplished by the addition of anti-catalysts or by the use of alloy electrodes.

Hale¹⁹ described a procedure based on the first idea²⁰. The nitrobenzene is reduced in a state of emulsion in 15% Be' sulphuric acid at a copper cathode in the presence of sticks of lead or at a lead cathode with the addition of small amounts of bismuth powder. A material yield of 50 per cent. is claimed.

The reduction at alloy cathodes has been described by Imray²¹ in his patent specification. A suitable alloy could be used as the cathode or the reduction could be conducted at a metal electrode, the other metal being added in the form of a salt. The amount of sulphuric acid was just sufficient to neutralize the bases formed. It has been claimed that yields in the proportion of 5 or 6 of aminophenol to one of aniline are obtained.

From the considerations set forth in the preceding pages, the most rational approach for evolving a technical method appears to be on the lines suggested by Imray and by the use of anti-catalysts. It is surprising that no work has been carried out on the basis of these ideas. For arriving at a proper assessment of the value of these ideas, a very large amount of experimental work will have to be carried out, considering that the variable factors like addition agents, current density, composition of electrodes, concentration of electrolyte and depolarizer, temperature, etc., are numerous. In the investigations reported in this paper all the factors could not be studied and the work had to be restricted to studies at a few selected cathodes at current densities most convenient for the operation of the cells with a few addition agents. The results of the preliminary study are given in Table I.

The most satisfactory results were obtained with copper or monel cathodes in the presence of mercury. The generally low yields in this series was due to the method adopted in working up the product. At the end of the reduction which was indicated by the disappearance of the smell of nitrobenzene, the sulphuric acid was neutralized by the addition of finely powdered calcium carbonate and the resultant product steam-distilled to remove aniline. The hot solution was filtered from calcium sulphate. Some *para* aminophenol was always lost along with the calcium sulphate, because of its low solubility in water.

Experiments were then conducted on a larger scale with the cathode combinations which proved satisfactory in the small-scale experiments. The results are given in Table II. The following remarks are offered in explanation.

(1) At monel cathodes with the addition of mercuric sulphate, *para* aminophenol is obtained in yields varying from 53 to 60 per cent.

(2) At copper cathodes with the addition of mercuric sulphate, *para* aminophenol is obtained in yields ranging from 53 to 61 per cent.

(3) In both cases, aniline is formed in yields ranging from 10 to 18 per cent.

(4) The use of sulphuric acid of *d* 1.2 was preferable to acid of *d* 1.12 although the yields obtained were nearly the same, the working of the product and cleaning of the electrodes were much easier with stronger acid. With the weaker acid, the solution was difficult to filter and a sticky deposit was formed on the cathode which was very difficult to remove.

(5) No corrosion of the cathodes was noticeable even after conducting a very large number of experiments in the same cells. Lead anodes gave good service provided the concentration of the anolyte acid was kept below 50 per cent.

(6) The anolyte acid increases in strength during the electrolysis. If the strength is allowed to rise above 60 per cent. the cell resistance increases and there is also considerable corrosion of the lead anodes. The anolyte is, therefore, withdrawn before this stage and fresh anolyte of 20 per cent. strength put in. Thus during a series of reductions fair quantities of sulphuric acid of nearly 60 per cent. strength accumulates and this can be re-employed after diluting suitably both as catholyte and anolyte. In

TABLE I

No.	Sulphuric acid (catholyte)		Effective cathode surface sq.dm.	Current		Cathode	Para aminophenol		Aniline		Nitro-benzene recovered gms.	Addition agents
	Nitro-benzene gms.	Volume cc.		Density amp./sq. dm.	Strength amp.	Total amp. hrs.	Yield gms.	Yield %	Yield gms.	Yield %		
1	200	750	5	6.0	30	327	44	24.8	42	27.7	—	Nil
2	200	750	5	6.0	30	260	74	41.8	37	24.5	—	10 gms. CuSO ₄
3	200	750	5	6.0	30	285	67	37.8	30	19.8	—	5 gms. Bismuth subnitrate
4	100	425	3	6.6	20	120	20	22.6	22	29.1	29	Nil.
5	100	425	3	6.6	20	120	48	54.2	9	12.4	1.6	5 gms. HgSO ₄
6	100	425	3	6.6	20	120	42	47.4	12	16.4	2	5 gms. HgSO ₄
7	400	1,900	20	3.0	60	438	110	25.4	80	26.5	—	Nil.
8	400	2,000	20	3.0	60	439	170	47.9	80	26.5	—	Lead sheet dipping
9	175	750	5	10.0	50	274	42	27.1	30	22.6	15	Nil.
10	175	750	5	10.0	50	260	47	30.3	35	26.5	15	Nil.
11	175	750	5	10.0	50	217	75	48.4	35	26.5	—	5 gms. HgSO ₄
12	175	750	5	10.0	50	203	65	41.9	35	26.5	—	5 cc. Sn(SO ₃) ₂ and 1 gm. HgSO ₄
13	175	750	5	10.0	50	238	62	39.9	35	26.5	—	1 gm. HgSO ₄
14	175	750	5	10.0	50	253	72	46.4	30	22.6	—	1 gm. HgSO ₄
15	200	750	3	10.0	30	285	66	21.3	24	9.1	—	Nil.

TABLE II

No.	Sulphuric acid (catholyte)		Effective cathode surface sq.dm.	Current		Cathode	Para aminophenol		Aniline		Nitro-benzene recovered gms.	Addition agents
	Nitro-benzene gms.	Volume cc.		Density amp./sq. dm.	Strength amps.	Total amp. hrs.	Yield gms.	Yield %	Yield gms.	Yield %		
1	1,000	4,250	40	2.5	100	1,585	360	40.6	75	9.9	—	30 cc. gum soln.
2	1,000	4,250	40	2.5	100	1,765	527	49.5	96	12.7	—	25 gms. HgSO ₄
3	1,000	4,250	40	2.0	80	1,090	475	39.5	85	11.2	—	25 gms. HgSO ₄
4	1,000	4,250	40	2.5	100	1,025	529	39.9	127	16.8	15	10 gms. HgSO ₄
5	1,000	4,200	40	2.5	100	1,700	535	60.4	100	13.2	—	10 gms. HgSO ₄
6	1,000	4,200	40	2.5	100	1,300	542	61.2	92	12.2	—	10 gms. HgSO ₄
7	1,000	4,200	40	2.5	100	1,250	572	58.1	127	16.8	—	10 gms. HgSO ₄
8	1,000	4,200	40	2.5	100	1,300	515	58.1	121	16.1	—	10 gms. HgSO ₄
9	1,000	4,200*	40	2.5	100	1,325	520	58.7	140	18.5	—	10 gms. HgSO ₄
10	1,000	4,200	40	2.5	100	1,050	475	53.6	123	16.2	12	10 gms. HgSO ₄
11	1,500	6,300	50	2.0	100	1,950	972	73.9	185	16.2	—	5 gms. CuSO ₄ and 5 gms. HgSO ₄
12	1,500	6,375	50	2.0	100	1,800	982	73.9	172	15.2	—	5 gms. CuSO ₄ and 5 gms. HgSO ₄

* Anolyte acid diluted.

experiments 8 and 9 (Table II) this procedure has been followed.

(7) Varying amounts of a dark green insoluble product were formed especially in the experiments employing mercuric or ceric sulphate as the addition agents. This is probably emeraldine. (Brigham and Lukens, *loc.cit.*).

(8) The older procedure described for the isolation of *para* aminophenol employing milk of lime or calcium carbonate for neutralization of the acid liquor containing the aminophenol, as well as the procedure described by Brigham and Lukens (*loc.cit.*) were found to be unsatisfactory. The procedure described in the experimental section (Procedure II) led to *para* aminophenol of high purity, which was almost colourless and melted sharply at 183° C.

(9) In the majority of experiments, the reductions were conducted till the smell of nitrobenzene was not perceptible. Hence the large amounts of current which had to be passed. This was not a very satisfactory commercial procedure since the smell of nitrobenzene is perceptible even in very low dilution and a large excess of current had usually to be passed. As seen from experiments 4, 7 and 10 (Table II) even with lower amount of current, equally good results are obtained and the amount of nitrobenzene left unreduced was very small. For the reduction of 1 kg. of nitrobenzene at a monel or copper cathode, 1,100 amp. hrs. would be sufficient to yield satisfactory results. Since the cell is operated at an average of 4 volts, 4.4 kw. hrs. would be theoretically required and assuming a generator efficiency of 80 per cent. 5.5 kw. hrs. would be actually consumed. With 500 gms. of aminophenol as an average yield from 1 kg. of nitrobenzene, the material yield is 56.4 per cent. and the yield per kw. hr. is 90.9 gms. (*cf.* McDaniel, *et. al.*, material yield 40-50 per cent.; yield per kw. hr. 40 to 50 gms.).

Para aminophenol can be manufactured by electrolytic reduction of nitrobenzene at copper or monel cathode and lead anode with a catholyte consisting of sulphuric acid of *d* 1.2 and containing 0.5-1 per cent. of mercury or cerium salt on the weight of nitrobenzene taken. The process is superior in simplicity of operation, high yield and purity of product and low upkeep charges, to the many other methods cited earlier in this paper and would, therefore, be most suitable for adoption on a technical scale.

The nitrobenzene is reduced in a state of emulsion in dilute sulphuric acid containing acid only a little more than what is required for neutralization of the products formed. The cathode and anode are of metals which are low in cost and of which plentiful supplies can be had. The corrosion of the electrodes is negligible. The cell voltage is reasonably low and the yield per kw. hr. is nearly 90 gms., nearly double that obtained in Gattermann or modified Gattermann procedures.

The process is illustrated in the accompanying flow-sheet.

It would be of interest to calculate the cost of production of aminophenol by this process. Since charges for interest, depreciation, supervision and overhead would depend to a large extent on the scale of production, the attempt is restricted to calculating the material and current costs. This has been done on the basis of the present Indian prices.

In a previous communication,²² the cost of nitrobenzene has been calculated as 17.28 annas per lb.

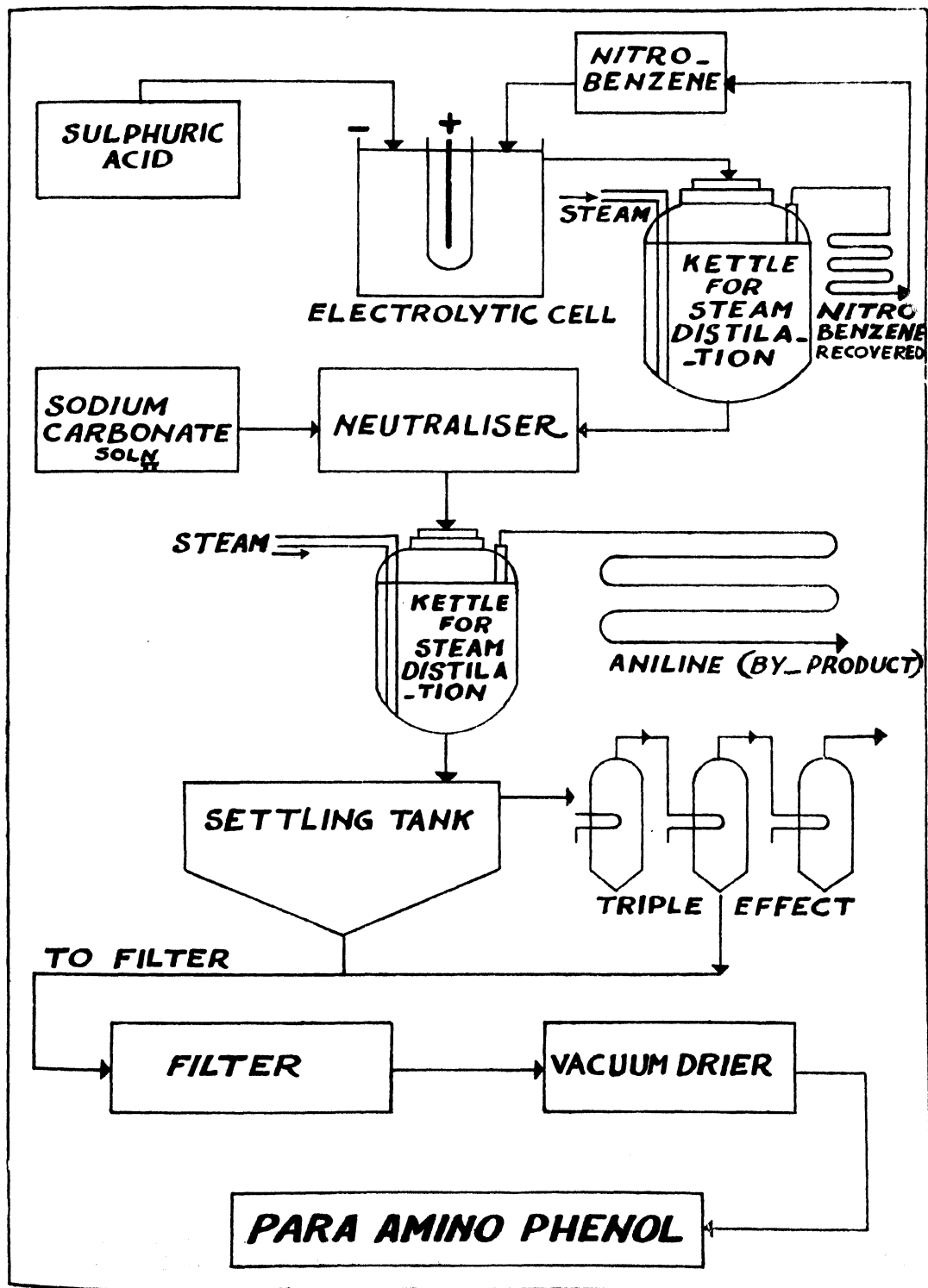
Materials to produce 500 gms. of para aminophenol—

	Annas
1,000 gms. of nitrobenzene at 17.28 as. per lb.	38.09
1,400 gms. of sulphuric acid at 2.14 as. per lb.	6.60
1,200 gms. of soda ash at 1.85 as. per lb.	4.89
5 gms. of catalyst at 15s. per kg.	0.80
Total	50.38

Credits

	Annas
Aniline, 125 gms. at 8d. per lb.	1.96
Net material cost for 500 gms. of <i>para</i> aminophenol	48.42
Cost of current, 5.5 kw. hrs. at 9 pies per unit	4.12
Cost of materials + current for 500 gms.	52.54
Cost per lb. of aminophenol	47.71 or Rs. 3

This figure does not include charges for interest, depreciation, supervision, overhead, etc.



Experimental

The current was supplied by a dynamo with an output of 100 amps. at 6 volts.

The diaphragms were of a special German manufacture and had an extraordinary resistance to acid.

The anodes were in all cases of lead and consisted of lead cylinders 2"-3" in diameter and 6" high. The anolyte was a 20 per cent. solution of sulphuric acid.

In the experiments listed in Table I, the following cells were used:—

Lead Cathode.—The cathode was of lead sheet bent into the form of a cylinder 5" diameter and 5" high with two slots 1" wide cut on opposite sides to within 1" from the bottom to allow the play of two glass stirrers. The cathode chamber is a 2-litre pyrex beaker in which the lead cathode is placed. The cell is provided with a lid of asbestos cement, with suitably placed holes for the cathode and anode leads and the bearing for the stirrers.

Copper Cathode.—The experiments handling 100 gms. of nitrobenzene were conducted in a cell similar to the above with a cylindrical cathode of copper of the same size. The large-scale experiments were conducted in a cylindrical vessel of copper 7" in diameter and 9" high, with a lid of asbestos cement.

Monel Cathode.—This consisted of two concentric monel cylinders 4" and 3" diameter inside a 2-litre pyrex beaker.

Carbon Cathode.—Two rectangular carbon pieces 5" long and 2.5" broad were suitably inserted through the asbestos lid fitted to a 2-litre pyrex beaker which served as the cathode chamber.

All the experiments at the above cathodes were carried out in cells provided with lids of asbestos cement. The nitrobenzene was kept in a state of emulsion by stirring, the stirrers being of glass or of the same metal as the cathode when convenient. A cylindrical porous diaphragm 5" high and 2.5" diameter was used in all the experiments with a lead cylinder 2" diameter and 4" high as anode.

At the end of the reduction, the acid solution was steam distilled to remove nitrobenzene, filtered from insoluble matter and neutralized with just sufficient calcium carbonate (Procedure I). The mixture was again steam-distilled to remove aniline and filtered hot from the calcium-sulphate. The residue was further washed with boiling water to remove any aminophenol. The filtrate was then concentrated *in vacuo* in an

atmosphere of hydrogen to about a third of the original volume. The crystals of aminophenol which were obtained on cooling were filtered, dried and weighed.

The experiments listed in Table II were carried out in cells of the following descriptions:—

Monel Cell.—The monel cell was a cylindrical vessel 10" diameter and 9" high manufactured from 15 gauge monel sheet, with the joints autogenously welded. Additional cathode surface was provided by a set of 20 vanes 4" by 2.5", welded to two monel rings, 9" diameter and 4" apart, placed inside the vessel and secured to it by bolts and nuts. There were two stirrers with monel blades and the vessel was provided with a lid of asbestos cement. Two porous diaphragms 2.5" diameter and 6" high were employed in which the lead anodes 2" diameter and 5" high were placed. (Fig. I).

Copper Cell.—The cathode chamber consisted of an oval copper vessel whose axes were 12" and 10" diameter 12" high.

Extra cathode surface was provided by a set of 20 vanes, 3" by 2" fitted to two copper rings whose axes were 11" by 9" and 4" apart. Three porous diaphragms with three anodes of lead were provided, of the same size as in the monel cell. The vessel was provided with a lid, two stirrers and bearings for the play of stirrers—all of copper.

The product was worked up as follows:—

At the end of the reduction, the acid solution is steam-distilled to remove nitrobenzene and filtered to remove insoluble matter. The acid solution is then neutralized carefully with a strong solution of soda ash (Procedure II) till the solution just turns red litmus blue. Sufficient acid is then added to make the solution just turn blue litmus red. A few cc. of a saturated solution of sodium bisulphite are then added and about 50-100 gms. of decolorizing charcoal. The mixture is then steam-distilled to remove aniline. It is absolutely essential that the mixture at this stage should not be even slightly on the alkaline side. The purity of the product obtained depends entirely on this. The distillate is worked up for aniline. The hot solution is filtered from the charcoal and the filtrate is only coloured pale yellow. On leaving overnight, preferably in the refrigerator, the major portion of the aminophenol crystallizes out and is filtered and dried. The mother liquor is concentrated *in vacuo* in a stream of hydrogen, the concen-

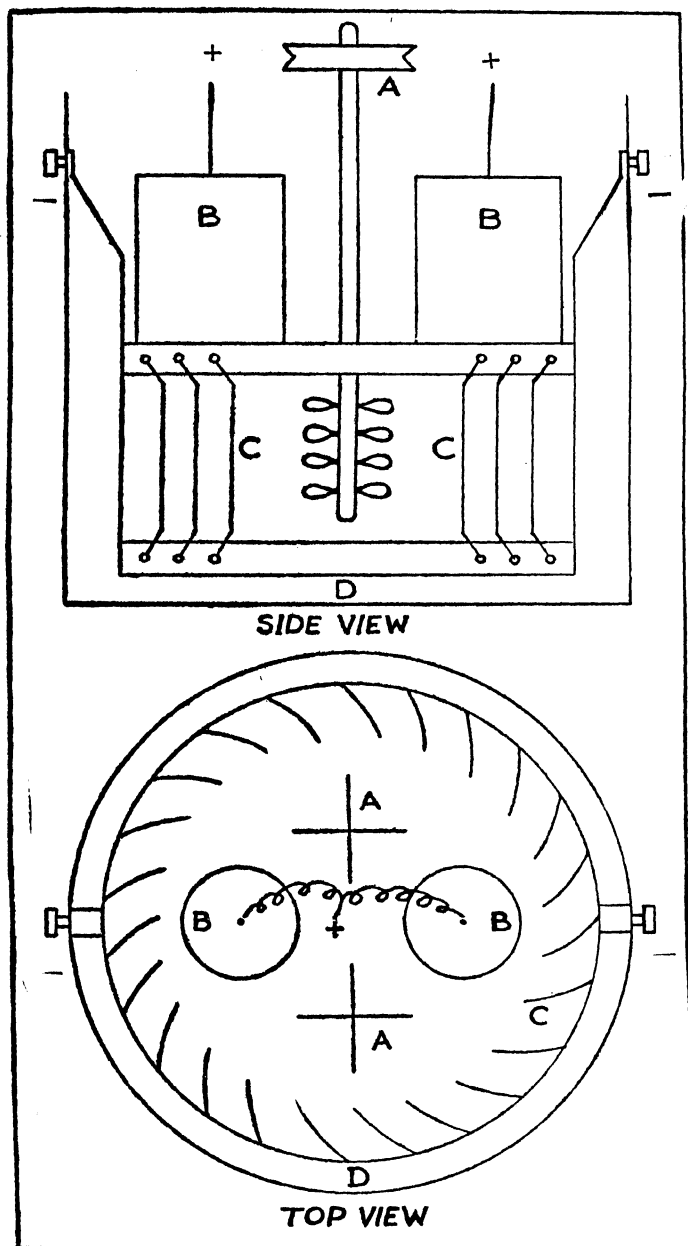


Fig. 1. Monel Cell.

A=Stirrers.

B=Porous diaphragms.

C=Vanes.

D=Cathode vessel.

tration being stopped just at the point when inorganic material starts separating. The solution is cooled, filtered and the residue washed with a small amount of water

containing sodium bisulphite. The aminophenol so obtained is dried and added to the main portion. (See flow-sheet.)

Our grateful thanks are due to the *Council of Scientific and Industrial Research* for a grant for carrying out this investigation and for permission to publish the results.

References

- 1 Paul, *Zeit. angew. Chem.*, **10**, 172; Lyons and Smith, *B.*, 1,27, 60, 180.
- 2 Barrowcliff and Carr, *Organic Medicinal Chemicals*, 1921, p. 118
- 3 Barrowcliff and Carr, *ibid.*, 121; A. Porai Koschitz, *Chem. Ztg.*, **49**, 595.
- 4 Vidal, *D.R.P.* 95,755.
- 5 Agfa, *D.R.P.* 205,415.
- 6 Dey, Govindachari and Rajagopalan, *J. Sci. Ind. Res.*, 1946, **4**.
- 7 Gattermann, *B.*, 1893, **26**, 1847; Bayer, *D.R.P.* 75, 260.
- 8 Noyes and Clement, *B.*, 1893, **26**, 990.
- 9 Darmstädter, *D.R.P.* 150,800 (1901).
- 10 Thatcher, *A.P.*, 1,501,472 (1920).
- 11 Caesar, *Trans. Amer. Elec. Soc.*, 1927, **52**, 95.
- 12 Elbs, *Electrolytic Preparations*, 1903, p. 70.
- 13 McDaniel, Schneider and Ballard, *Trans. Amer. Elec. Soc.*, 1921, **39**, 441.
- 14 Boehringer, Sohne and Messinger, *D.R.P.*, 109,051 (1898); Nithack, *D.R.P.*, 123,354 (1899).
- 15 Burwell, *Trans. Amer. Elec. Soc.*, 1927, **52**, 107.
- 16 Shoji, *J. Chem. Ind., Tokyo*, 1918, **21**, 117.
- 17 Brigham and Lukens, *Trans. Amer. Elec. Soc.*, 1932, **61**, 281.
- 18 Bamberger, *B.*, 1894, **27**, 1552.
- 19 Hale, *The application of Electrolysis in Chemical Industry*, 1919, 52.
- 20 Gessellschaft fur Chemische Industrie, *D.R.P.* 295,841; Chemischen Fabrik Grünau, *D.R.P.* 437,002.
- 21 Imray, *E.P.* 18,081 (1915).
- 22 Dey, Govindachari and Rajagopalan, *J. Sci. Ind. Res.*, 1946, **4**, 569.

YEAST GROWTH METHOD FOR THIAMIN ESTIMATION

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MICROBIOLOGICAL methods of vitamin assay have recently been shown to be among the most sensitive and accurate. Schultz, *et al.*^{1,2} first initiated and developed the yeast fermentation method for an accurate estimation of thiamin. The method is based on the fact that thiamin stimulates the rate of output of carbon dioxide by yeast. Substances other than thiamin are, however, now known to influence this rate; these, if present, would introduce errors. The authors have sought to eliminate such errors by (1) improved methods of extraction, and (2) the employment of a control in which thiamin is selectively destroyed by sulphur dioxide without affecting the other interfering substances^{3,4}.

Bunzell⁵ employs the Catox apparatus for determining the rate of fermentation. This method, though requiring only 3-4 hours, needs fairly elaborate equipment. We have, in this paper, described a simple and accurate technique, based on the fact that yeast growth, within certain limits, is directly proportional to the concentration of thiamin. The degree of this response varies with different strains of yeasts. Williams, *et al.*⁶, suggested a method for thiamin estimation in which the turbidity developed by yeast growth was photoelectrically measured. A simpler technique would consist in measuring the growth by a hemacytometric count of the cells in the medium. Williams, *et al.*, have used this method with *S. cerevisiae*. A strain of *Torula utilis*, found to respond linearly over a wider range of (0.01 μ g—4 μ g/cc.) thiamin concentration, has been employed in our studies. The method needs only a microscope and a hemacytometer besides the routine laboratory equipment.

Experimental

Reagents.—The basal culture medium is made up as follows:—

	gms.
Dextrose	175.0
Ammonium sulphate	5.62
Potassium dihydrogen phosphate	5.62
Magnesium sulphate	5.00

	gms.
Calcium chloride	1.00
Ferrous sulphate	0.25
Copper sulphate	Traces
Water	to make up 1 litre
pH	4.2-4.6

Thiamin standard.—Pure crystalline thiamin hydrochloride is dissolved in water at pH. 4.6 to give a concentration of 0.6 μ g/cc. This stock solution is preserved in a refrigerator.

Yeast suspension.—A strain of *Torula utilis*, grown for generations on the basal medium, is eminently suitable for this estimation. 1 cc. of the culture diluted with sterile water giving a count of 4-5 cells per 80 squares of the hemacytometer is adequate.

Method of assay: Preparation of the sample.—A known weight of the sample is thoroughly ground with wet white sand at pH. 3.0—4.0. The suspension is heated at 100° C. for 20 minutes, cooled and made up to a known volume. An aliquot equal to half of this volume is treated with sulphite to inactivate the thiamin present after the method of Schultz, Atkin and Frey⁴, and serves as the control. The remaining portion serves as the test solution. The sulphite-treated and the untreated portions after adjusting the pH. to 4.2 to 4.6, are both made to the same volume with sterile water. The solutions, if necessary, are centrifuged at high speed to secure a clear solution.

Treatment with sulphite.—An aliquot of the solution (20 cc.) is pipetted into a 100 cc. conical flask, 0.7 cc. of N. sulphuric acid and 5 cc. of a freshly prepared solution of sodium sulphite containing 0.2 gms. of $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ per 5 cc. added. The reaction is adjusted to pH. 5.2—5.6, with bromocresol purple as external indicator. The flask is capped with a small beaker, heated at 100° C. for 30 minutes and then cooled. The excess of sulphite is destroyed by an equivalent quantity of hydrogen peroxide (3 per cent. solution), the end point of the reaction being determined externally with the aid of the starch-iodide test. The solution is brought

to pH. 4.2 and made up to the same volume as that of the test solution.

Procedure.—In each of six cleaned and sterilized test tubes, 4 cc. of the basal medium are taken, to which are added respectively 0.0, 0.5, 1.0, 2.0, 3.0, and 4.0 cc., of the standard thiamin solution (in tubes marked 1, 2, 3, 4, 5 and 6 respectively). Further 5.0, 4.5, 4.0, 3.0, 2.0 and 1.0 cc. of sterile distilled water are added to these tubes respectively. 1 cc. of yeast suspension is added to each tube to make the total volume to 10 cc. The tubes 1, 2, 3, 4, 5 and 6 thus contain 0.0, 0.03, 0.06, 0.12, 0.18, and 0.24 $\mu\text{g}/\text{cc.}$ of thiamin. The tubes are incubated at 30° C. for 24 hours, at the end of which a drop of 2 per cent. phenol is added to check the growth of yeast and the cell counts are taken with the help of a hemacytometer. Duplicates are run in each case. The results obtained are used to construct a standard reference curve (Curve I, Fig. 1).

A typical assay.—In each of three test tubes, 4 cc. of basal medium are taken. To tube 1, 2 cc. of sulphite-treated solution are added (sulphite control) and to tubes 2 and 3, 2 cc. of the untreated solution are pipetted (tube 2 serves as untreated control). Further, 0.5 cc. of standard thiamin solution is added to tube 3. The total volume is brought up to 9 cc. in each tube by sterile water and

the tubes inoculated with 1 cc. of yeast suspension. Duplicates are run in each case. The tubes are incubated at 30° C. for 24 hours, after which a drop of 2 per cent. phenol solution is added and the counts taken. If the yeast cells are too great in number or show any cluster formation, the suspensions are diluted with 0.5 per cent. sulphuric acid so as to bring the counts within the range of observation. The vitamin content is read off by reference to the standard curve (I, in Fig. 1).

The results of assay of a few common food materials are given in Table I. The thiamin values recorded in the table were read off from the standard curve (I, Fig. 1).

From the values given in Table I, the thiamin contents of barley, wheat, wheat-germ, rice and wheat flour can be computed. The values are respectively 6.2, 4.0, 24.25, 1.6, and 3.6 $\mu\text{g}/\text{gm.}$

Sensitivity of the method.—In order to investigate the sensitivity of the method, further recovery experiments were made. An assay extract was prepared from cholam (*Sorghum vulgare*) and varying amounts of thiamin (0.01 $\mu\text{g}/\text{cc.}$ —0.10 $\mu\text{g}/\text{cc.}$) were added to it. The stimulation produced in yeast growth was read off from the standard curve. The results obtained are given in Table II and plotted in a graph (II, Fig. 1).

TABLE I. Results of Typical Assays.

Tube No.	Assay solution	Thiamin added $\mu\text{g.}$	Yeast count per 80 sq.	Growth stimulation from reference curve in terms of thiamin	Thiamin content $\mu\text{g}/\text{cc.}$	Recovery %
<i>Barley</i>						
1.	Sulphite treated	—	163	0.059	—	—
2.	Untreated	—	186	0.090	0.031	—
3.	Untreated+	0.03	207	0.119	0.060	96.6
<i>Wheat</i>						
1.	Sulphite treated	—	129	0.012	—	—
2.	Untreated	—	145	0.032	0.020	—
3.	Untreated+	0.03	170	0.063	0.051	103.3
<i>Wheat-germ</i>						
1.	Sulphite treated	—	149	0.036	—	—
2.	Untreated	—	184	0.080	0.044	—
3.	Untreated+	0.03	207	0.110	0.074	100.0
<i>Rice</i>						
1.	Sulphite treated	—	145	0.032	—	—
2.	Untreated	—	152	0.040	0.008	—
3.	Untreated+	0.03	175	0.069	0.037	98.3
<i>Wheat-flour</i>						
1.	Sulphite treated	—	127	0.018	—	—
2.	Untreated	—	144	0.035	0.017	—
3.	Untreated+	0.03	166	0.065	0.047	100.0

TABLE II. Thiamin content of the untreated solution, 0.013 $\mu\text{g}/\text{cc.}$

Tube No.	1	2	3	4	5	6	7
Thiamin added, μg	—	0.01	0.02	0.04	0.06	0.08	0.10
Yeast count per 80 sq.	97	101	105	112	122	129	136
Total thiamin, μg	0.013	0.023	0.033	0.052	0.077	0.095	0.113
Thiamin recovery %	—	100.0	100.0	97.5	106.6	103.0	100.0

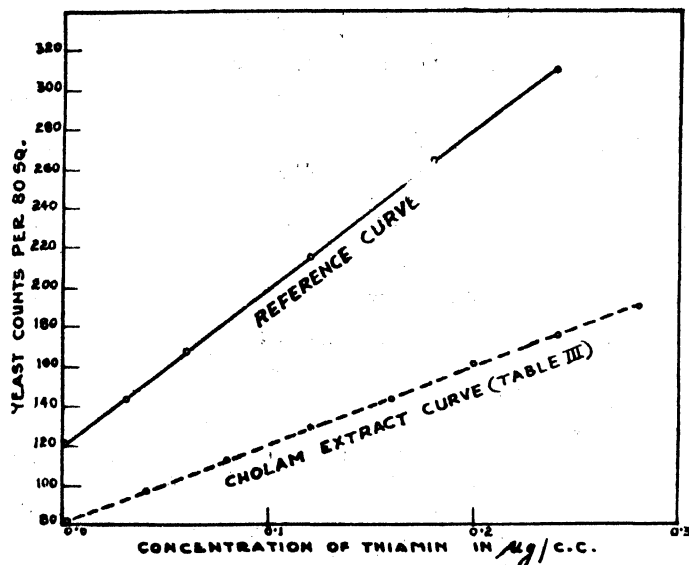


Fig. 1. Standard curves showing the effect of thiamine on the growth of yeast (*Torula Utilis*)

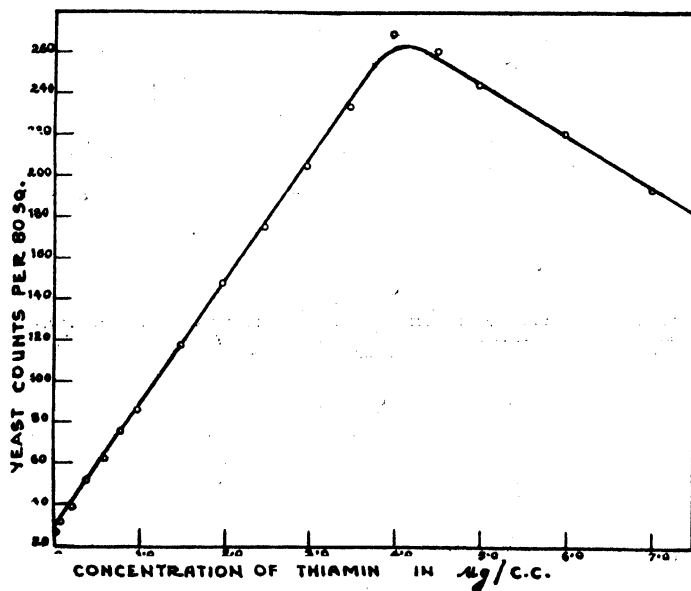


Fig. 2. Effect of thiamine on the growth of yeast (*Torula Utilis*)

The results show a recovery of 97.5–106.6 per cent., the maximum index of error being 2.5–6.6 per cent. over a range of 0.01 $\mu\text{g.}$ to 0.10 $\mu\text{g.}$ of thiamin per cc.

Range of determination.—Attempts have been made to determine the minimum and maximum quantities of thiamin which can be determined by this method. The results

obtained are presented in Fig. 2.

The graph reveals that the relationship between the thiamin content per cc. and the growth of yeast is linear upto 4 $\mu\text{g./cc.}$ Beyond this, any increase of thiamin in the medium causes a relative decrease in the yeast growth. For this reason, the yeast growth method can be used for the estimation of thiamin content of the medium over a range of 0.01 to 4.0 $\mu\text{g./cc.}$

Further work is being carried out on the application of the method for the estimation of the thiamin contents of various foodstuffs. The results will be compared with those obtained by the standard thiochrome method.

The authors are grateful to the Council of Scientific and Industrial Research, for financing a scheme on the study of yeasts, of which this work forms a part.

Summary

1. A simple method for the estimation of thiamin based on the growth of an adapted strain of yeast is described.

2. Data are presented to show that the method gives reliable results (max. index of error, 2.5–6.6 per cent.) in the range of 0.01–0.10 $\mu\text{g./cc.}$ of thiamin.

References

- 1 Schultz, A. S., Atkin, L., and Frey, C. N., *J. Am. Chem. Soc.*, 1937, **59**, 948, 2457.
- 2 Schultz, et al., *ibid.*, 1938, **60**, 3084.
- 3 Schultz, A. S., Atkin, L., Frey, C. N. and Williams R. R., *J. Am. Chem. Soc.*, 1941, **63**, 632.
- 4 Schultz, et al., *J. Ind. & Eng. Chem., Anal. Ed.*, 1942, **14**, 35.
- 5 Bunzell, H.H., *J. Ind. & Eng. Chem., Anal. Ed.*, 1942, **14**, 279.
- 6 Williams, R. J., MacMahan, J. R. and Eakin, R. E., *Univ. Texas., Pub.*, 1941, **31**, 4137.



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FOREST CONSERVATION AND EXPANSION

ADDRESSING the Convocation of the Indian Forest College and the Indian Ranger Forest College at Dehra Dun on 30th March 1946, the Hon'ble Sir Jogendra Singh, Member for Agriculture, observed:

"Probably few people are aware that forestry is the second biggest industry in the world, agriculture of course being the first. But in spite of its importance, many countries have not in the past realized the value of their forests either as a stabilizer of climatic and physical conditions of the land or have not appreciated the stark necessity of trees and forests for the economic well-being of the rural population.... Throughout the world now, however, there is a great awakening; it is now being realized that forests must be conserved as a great permanent source of national wealth."

These remarks, appropriately enough, have been made at a time when vast schemes for the conservation and extension of forests, and for the training of personnel for forestry and forest research, are being considered in India. Forests are Nature's gift to man, but their indiscriminate and unscrupulous exploitation through ignorance and greed have seriously affected their protective role and created problems with which man is now trying to grapple. The problem the world over is the same—depleted forests causing soil movement and an ever expanding demand for timber. Man's attempt to settle in new areas, expand agriculture and meet commercial demands for timber, have often been accompanied by a failure to recognize the dangers of interference with Nature, and

such interference with the natural cover of vegetation has nearly always been the cause of disaster.

Forestry and Agriculture

There is no conflict between the two forms of land utilization, viz., agriculture and forestry. Forests in fact help agriculture. On a functional basis forests have been classified into "protection forests" or those necessary for maintaining climatic and physical conditions, and other types which supply timber, fuel, grass and "minor forest products." In the movement of water from the stage of precipitation to its reaching, as run off, the streams and finally the ocean, the longer the precipitation remains in circulation over the land the greater is its use. The effect of the forests is that they tend to prolong the retention of water on and in the soil. In deep soils a large reservoir of water is retained which feeds the streams gradually and regularly, thus preventing exceptionally high rises resulting in floods or low levels which diminish agricultural use. This is probably an over-simplification of the complex factors that govern the forest-soil-water cycle, but it will be apparent that forests serve to conserve water and prevent rapid run-off causing soil erosion and river floods.

Soil erosion has assumed disastrous proportions in India. While much of it is due to the destruction of forest, the breaking of natural grassland is equally destructive in semi-arid regions, where the erosion may be due to sudden storms or more frequently to strong winds and its prevention calls for wise

measures of forest conservation and large schemes of afforestation.

The distribution of forests in India is by no means even or adequate to prevent floods and erosion. In the Central Provinces, where the forests are well distributed and are adequate in quantity, there is no serious erosion problem; but in all other Provinces erosion on a large scale is continuing outside the areas managed by the Forest Department, and planned afforestation suggests itself as a preventive measure.

The problem of reclaiming the desiccated areas roughly to the west of the line running from Ambala via Etawa to Ratlam and across to Mount Abu, appears to be equally serious and afforestation again affords a possible solution. Referring to this area, Sir Herbert Howard observes*:

"It has been stated, though I have no actual evidence, that the desert conditions are spreading eastwards and that the country over all this tract is getting drier. Whether this is correct or not at present, it is an obvious danger. Without entering upon the controversial question of forests increasing rainfall, it is an acknowledged fact that forests do conserve what rainfall there is, prevent evaporation, generally mitigate the extremes of climate and are a great adjunct to agricultural dry farming, which presumably must be practised over much of this area. Apart, therefore, from increasing the general fertility and improving the climate over the tract itself and preventing dust-storms, the afforestation of this area would undoubtedly act as a barrier against the spread of desert conditions and preserve the fertility of the gangetic plain to the east of the 30" rainfall line."

It will be appreciated that planned afforestation provides a means of reclaiming for agricultural purposes, lands threatened by floods and of checking the spread of desert conditions. Sir Herbert Howard draws attention to another important aspect of agriculture which can be promoted by a wise policy of dispersed afforestation. In the majority of British Indian Provinces, owing to the very uneven distribution of forests, the wants of the vast population of village consumers for fuel are left unmet and the villagers are forced to burn cowdung with

the result that a very valuable fertilizer is lost. On a very conservative estimate, about 250 million tons of cowdung, enough to fertilize 72 million acres or roughly 30 per cent. of the total acreage of agricultural land in India, is thus burnt and lost. When it is realized that through proper manuring the yield of agricultural crops can be easily doubled, it will be realized that food production in India is being seriously jeopardized by the destruction of valuable manure and this is occasioned by the lack of adequate fuel resources which can and ought to be met by afforestation.

Besides agriculture, forests provide valuable raw materials for a variety of industries, such as house-building, matches, pulp and paper. Modern technology has evolved, through special treatment, new materials from wood which compete with metals. Chemical research has opened up amazing possibilities for utilizing wood as raw material for industries. The "minor forest products" comprise a large variety of materials with numerous industrial applications. The production of wood for its varied uses, all over the world, is reported to be 1.2 billion tons, second only to that of coal, which is fossil carbonized wood, estimated at 1.3 billion tons.

Is Afforestation Possible ?

The question now arises, is India well provided with forests? It is difficult to estimate with any degree of precision the minimum forest area necessary for the well-being of a country. In the European countries, the average forest area in a State, according to figures collected by Sir Herbert Howard, amounts to 26 per cent. In India, the forest area under Government control is estimated at 14 per cent., and if to this is added the area covered by private owned forests—which are ill-managed and are fast disappearing due to excessive timber-felling and unchecked cattle-grazing—the total area will not exceed 20 per cent. It is clear that in British India the total area of forest is less than that required, and its distribution is bad.

The need for large-scale afforestation is clear. Afforestation is necessary for preventing soil erosion, floods and desiccation, for providing the fuel requirements of the village consumer and for providing essential raw materials for industry. The land required for afforestation is fortunately available. It

**Post-war Forest Policy in India*, printed by the Manager, Government of India Press, New Delhi, 1944.

is estimated that 288,000 square miles of land, half of which is classed as "cultivable waste" and the other half as "not available for cultivation" remains unused in India. Much of the land under the second category may, in fact, be suitable for raising forests of some sort. The requirements will be met if one-third of the area now uncultivated is utilized for establishing forests.

Training and Research

The problems briefly mentioned above provide but an indication of the manifold aspects of the work essential for restoring the forest estate to its proper place in the national economy. It is, however, one thing to state the problems, gather scientific data and lay down a plan of action, but quite a different thing to put the plan into execution and achieve results. The work calls for the provision of a large number of trained men, both of the officer and ranger classes. The Hon'ble Sir Jogendra Singh rightly stressed the need for large-scale forest

education in his address. The need for research men and research facilities is no less imperative. The most efficient use of woodlands that have survived the war, and of further lands available for afforestation involve a vast field of research into primary forest soils, tree physiology and forest ecology in the widest sense. Large-scale plantation of countryside is likely to be accompanied by the invasion of local pests and even the appearance of new ones, and researches in forest entomology and mycology have to be undertaken for the control and eradication of pests and diseases. There are, besides, numerous problems relating to the utilization of wood and minor forest products. All these involve expenditure of large sums of money. In forestry, necessitating long-range planning—since trees do not grow to maturity in the brief space of agricultural crops,—stability of budget provision is essential. These requirements have to be met adequately if forest development is to be real and lasting.

A ROAD RESEARCH INSTITUTE FOR INDIA

THE Industrial Research Planning Committee of the *Council of Scientific and Industrial Research* recommended the establishment of a number of specialized research institutes including a Road Research Institute, in addition to the five National Research Laboratories.

A large amount of money is being spent on the construction and maintenance of roads and bridges in India. In order to ensure that this money is properly utilized, it is necessary to formulate basic standards of materials and designs, and the establishment of a Road Research Institute, on the lines existing in other progressive countries, would help such a formulation. The *Indian Road Congress* had suggested :

- (i) that road research should be conducted in India on the same general lines as those in U.K. and U.S.A. ;
- (ii) that a Central Road Research Institute should be established with experimental field stations at various suitable places in different parts of India ;

- (iii) that this Institute should work under the *Council of Scientific and Industrial Research* through a Road Research Board which should be set up ;
- (iv) that road research should be linked with building research, the Institute and the main testing stations being sited close together ; and
- (v) that all work on existing road testing and experimental stations should be co-ordinated by the proposed Road Research Board.

The War Transport Department forwarded a note to the Industrial Research Planning Committee recommending, *inter alia*, the establishment of a Road Research Institute in the post-war period. The War Transport Department's suggestion regarding an organization of Road Research is summarized as under :

- (i) A Road Research Institute should be established under the auspices of the *Council of Scientific and Industrial Research*. The *Council* should be

responsible for the Institute and the laboratory staff. The Institute should have one main field experimental station near the Institute and the other field stations should be situated at various suitable places in different parts of the country. The field experimental stations will be financed by the Central Road Research Board.

- (ii) A Road Research Board should be set up under the *Council of Scientific and Industrial Research* for directing the research programme of the Institute.
- (iii) There should be two road test tracks. One is already existing at Calcutta and the other should be set up at Delhi.
- (iv) The Director of the Laboratories should in the first place be an engineer-scientist of eminence to be imported from abroad on contract but he should have an Indian understudy who should ultimately take over from him.
- (v) A Director of Technical Co-ordination should be appointed by the War Transport Department who should no doubt work in the closest possible co-operation with the proposed Road Research Organization under the *Council of Scientific and Industrial Research*.
- (vi) A Road Research Advisory Council should be established (as in U.K. and U.S.A.) for co-ordination of all road research and experimental work and guide the work of the Director of Technical Co-ordination.

The War Transport Department considered that for the proper development of road research, an organization as proposed by the Indian Road Congress should be set up and accordingly recommended that the principal officers who are to take charge of the organization should be appointed early to draw up plans. The Consulting Engineer (Roads), War Transport Depart-

ment, suggested that the proposed Institute should be situated near one of the big arterial roads for the purpose of field work. Delhi was recommended as a place for the proposed Institute. The capital expenditure envisaged was Rs. 13.5 lakhs, and in the first five years the annual recurring expenditure was estimated to be Rs. 4 lakhs, bringing the total to Rs. 17.5 lakhs.

The *Council of Scientific and Industrial Research* agreed in principle to the setting up of a Road Research Institute and with this object in view a joint meeting of the representatives of the *Council of Scientific and Industrial Research* and the War Transport Department was held for drawing up detailed plans and for suggesting the functions, scope, etc., of the Institute. The Committee recommended the scheme as formulated by the Consulting Engineer (Roads) of the War Transport Department for adoption. The Governing Body of the *Council of Scientific and Industrial Research*, at their meeting held on the 18th January 1946, approved the recommendations of the Joint Committee.

With a view to launch the proposed scheme of organizing road research, two committees—one the Road Research Advisory Committee and the other the Road Research Assessors—have been constituted. Efforts are being made by the *Council* to appoint a Director of the Road Research Institute by advertising in India, U.K. and U.S.A. The appointment of a Director of Technical Co-ordination will be made by the War Transport Department. In order to obtain best results from the proposed organization the two Directors will work in close collaboration.

The financial implications of the scheme have been accepted in principle and for the year 1946-47 a capital grant of Rs. 7.5 lakhs and a recurring expenditure of Rs. 2 lakhs have been made available to the *Council* by the Government of India. The Institute will be located at Delhi and efforts are being made to obtain a suitable site.

THE LARGEST SUN SPOT GROUP OF MODERN TIMES

By A. L. NARAYAN

(Solar Physics Observatory, Kodaikanal)

ON 30th January 1946, the largest spot-group of modern times made its first appearance on the east limb of the sun at latitude 27° N. and it was fully in view the following day. The unusual size of the spot-group made the sun's disc an impressive sight. The group at first consisted of only two spots. These developed rapidly into a large active group, the leading spot having begun to disintegrate into several small spots. At the same time, the following spot grew in size and consisted of a single penumbral patch of irregular outline with several umbrae scattered over it. By 4th February 1946, the spot-group attained an area of 3,500 millionths of sun's visible hemisphere, which places it among the largest of the present century. The spot-group was of the bi-polar type in which, contrary to the general course of development, the following member was larger, more stable and more active. It crossed the Central Meridian on 5th February 1946 and finally disappeared on the west limb of the sun on 12th February 1946. Even on 2nd February 1946, it was felt that groups of this type were generally most likely to cause magnetic storms and ionospheric disturbances. A close watch was, therefore, kept and special observations were made on the spot-group during the time the group was in transit across the disc of the sun, the average number of hours of observations per day being 8. Unfortunately, owing to cloudy weather, no observations could be made on 4th and 6th February 1946.

The spot-group was active from the very beginning, showing frequently doppler displacements and bright chromospheric eruptions. A number of bright eruptions were recorded on all the days between 3rd February and 7th February 1946. From the information received from the *Cable and Wireless Ltd.*, London, there was a major radio fade-out on 6th February 1946 between 03h.—30m. and 06h.—20m. (G.M.T.). Besides this, radio fade-outs and abnormal reception conditions were observed by the All-

India Radio, Research Department, New Delhi, on several days between 31st January 1946 and 15th February 1946. A list of these fade-outs which were kindly passed on to us by All-India Radio, New Delhi, is given in the table below.

TABLE I.

Date, 1946	Time of fade-out (I.S.T.)	Remarks.
Jan. 30	12.00—15.00	Fade out. All stations weak. No trace of Calcutta, Bombay, Madras.
Feb. 2	13.00—16.15	Fade out of all A.I.R. shortwave regional transmitters. 14.30 fade out of B.B.C., G.S.J. very poor after 15.45. Reception of Eastern stations also poor.
.. 3	09.30—12.00	Complete fade of A.I.R. shortwave regional and B.B.C. stations.
.. 4	11.30—12.00	Sudden fade-out of all stations.
.. 5	12.00—13.00	Fade-out of all stations.
.. 6	12.00—13.00	Fade-out Calcutta, Bombay and Madras.
.. 8	11.00—12.30	No trace. B.B.C. normal after 13.00
.. 11	10.00—11.00 16.30—11.45	No trace of any B.B.C. and A.I.R. shortwave regional stations. Partial fade-out of all B.B.C. stations. Partial fade-out of A.I.R. shortwave regional and B.B.C. stations.
.. 13	09.30—10.00 17.08—17.50	Fade out. No trace of B.B.C. stations. Sudden fade out of all stations. By 17.35 B.B.C. 15 and 17 Mc./s. stations struggling through. 17.50 all stations normal.
15	09.30—11.00	Partial fade out all B.B.C. stations.

TABLE II.

Largest Sun Spot-Groups—1890-1946.

Year	Date of Central Meridian Passage of Spot-group	Maximum area in millionths of sun's visible hemisphere
1892	Feb., 11	2788
1892	July, 10	2167
1893	Aug., 7	2391
1894	Oct., 8	2285
1896	Sept., 16	2233
1897	Jan., 9	2508
1905	Feb., 4	3094
1905	Mar., 7	2345
1905	Oct., 20	2758
1907	Feb., 12	2327
1907	June, 19	2246
1917	Feb., 9	3342
1917	Aug., 10	2934
1920	Mar., 21	2459
1925	Dec., 28	2696
1926	Jan., 24	3466
1928	Sept., 27	2359
1937	Jan., 31	2343
1937	July, 24	1665
1946	Feb., 5	3580

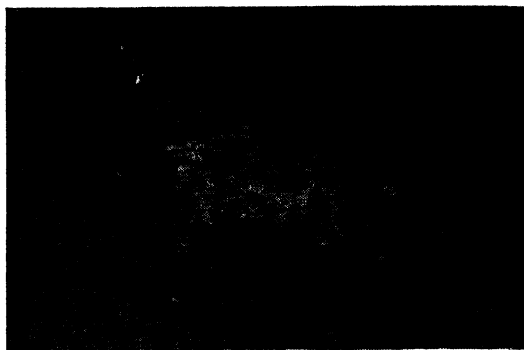


Disc photograph of the sun in Ca light showing the bright eruption near the recent largest sun-spot group.



The largest sun-spot group of modern times as photographed at Kodaikanal Observatory.

The Alibag Observatory, Bombay, reported a magnetic storm of slight intensity which commenced on 7th February 1946 (evening) and ended on 8th February 1946 (evening). Undoubtedly, these ionospheric and magnetic disturbances were associated with this remarkable sun spot-group. Since sun spot activity will continue to increase during the next three years and this group is the largest of the present century, a comparison of this spot-group with some of the largest, carefully observed during this century and a few words about the established general features of sun spots may be appropriate.



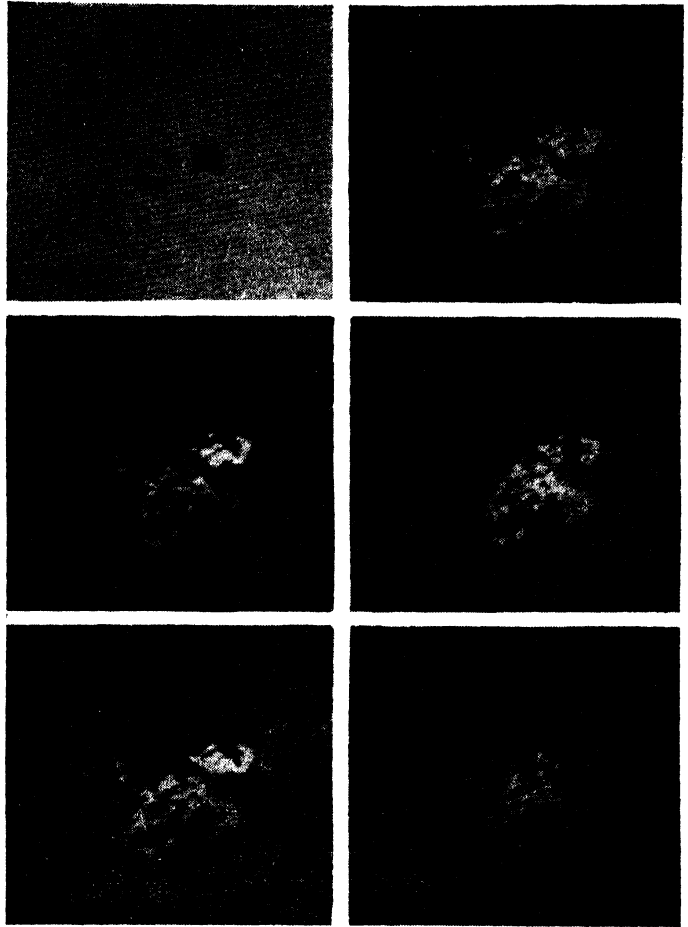
Various types of hydrogen flocculi.

The twenty largest spot-groups that appeared from 1890 are listed in Table II.

A spot-group with an area of 1,000 is generally considered "Large" and can be easily seen with the naked eye through a piece of smoked glass. It will be seen from this that if the twenty spot-groups in the table are arranged according to area, the spot-group of February 1946, will be the first. Further, during the last fifty years, only four spot-groups have attained an area of more than 3,000.

Photographs of the sun taken in the light of calcium or hydrogen show that the

general surface of the sun is not uniformly bright, but, shows considerable numbers of detached granules. These granulations are 300 to 400 miles in diameter and are subject to rapid fluctuations indicative of the turbulent conditions of the solar atmosphere. But, most obvious of solar surface disturbances are the large dark areas known as sun-spots. They are really luminous, but dark only by contrast. They are regions of low pressure and their darkness is obviously caused by the cooling of gases expanding into the affected area. These spots vary greatly in size and on rare occasions, may be almost 15 to 20 earth-diameters across. The average life of a spot is one or two months. The largest lived spot on record is that of the years 1840-41 which persisted for 18 months. The shortest lived is generally a few hours' duration. Sun-spots have indeed been observed for nearly 150 years. They increase to a maximum number, decrease to a minimum, then rise again to a maximum in regular sequence. They show a definite periodicity. Since 1900, there has been maximum spottedness at the following times: 1906.4; 1917.6; 1928.4; and 1937.4 and minimum spottedness at 1901.7; 1913.6; 1923.6; 1933.8; and 1944.3.* It is easily seen from these figures that there is a variation of the spottedness of the sun possessing a period of roughly 11 years. Further, sun-spots occur only within certain belts of solar latitudes; beyond the confines of these two belts, defined by 6° and 40°—the one in the northern hemisphere and the other in the southern hemisphere—spots very rarely occur. Observations made at Kodaikanal and Mt. Wilson, have conclusively demonstrated that sun-spots are huge solar cyclones—whirlwinds in the solar atmosphere—accompanied by pronounced magnetic conditions. As a result of the whirling of electrically charged particles



A bright chromospheric eruption of 2nd July 1937.

in it, each sun-spot is a huge magnet. The question is how the enormous currents of electricity—which must be of the order of millions of amperes—are set up and maintained.

The spectroheliograms are of great value in showing the general structure of the solar atmosphere. The most interesting, and the most significant structure is that shown by dark and bright clouds of hydrogen and calcium vapour which are otherwise called "flocculi." Active as well as quiescent flocculi are frequently observed. Quiescent bright flocculi are almost always visible in the neighbourhood of spot-groups. Generally, they attain considerable intensity specially over large spot-groups. But, they never show rapid changes in form or intensity. Active bright flocculi which are far brighter

* The figure after the point refers to the number of the month. Thus 1906.4, stands for 1906 April; 1917.6 stands for 1917 June.

than the quiescent ones change rapidly in form and intensity. They are usually called bright chromospheric eruptions and they usually appear suddenly close to active sun-spots, become extremely brilliant and spread over large areas. The extraordinary feature of these eruptions is the rapidity with which the outburst develops. From 5 to 15 minutes is the time required for most of them to attain maximum intensity. Bright chromospheric eruptions are not an exceptionally rare or unusual form of solar activity, but, only they appear to be so on account of their ephemeral nature and want of continuous observations. These phenomena have in recent years assumed special interest because of the well-established coincidences of eruptions with radio fade-outs and disturbances in earth's magnetic field. It has been found that chromospheric bright eruptions produce terrestrial effects throughout the day-lit hemisphere on the earth. There is evidence that magnetic storms are also caused by these eruptions; but, with an interval of 20 to 25 hours between the eruption and the commencement of the storm, intense magnetic storms are known to occur when large active spot-groups are near the central meridian.

Spectroscopic analysis of the light from these solar flares shows that they are composed mainly of calcium, hydrogen and helium. The visible radiations of these eruptions cannot obviously account for the observed results on the earth, indicating that an immense increase in the ultra-violet radiation must accompany them. Many of the effects are probably attributed to blasts of ultra-violet radiation and electrified clouds of matter, reaching the earth. The conclusion should be that chromospheric eruptions notwithstanding their localized appearance are manifestations of some deep-seated phenomenon, though the origin of the forces involved is still unknown. The effectiveness of such eruption in producing fade-outs, depends mainly upon the area of the region affected and upon the intensity of the eruption; but not upon the position on the solar disc. This independence of position may be attributed to the heights to which the emitting gases are thrown. Definite conclusions on this must await measurement

of relative intensities of spectral lines present in the eruption.

During eruption, the presence of huge magnetic fields in sun-spots obviously results in their acting as "Howitzers" to pour forth charged particles of matter into the surrounding inter-planetary space. If the earth happens to be in the range of the howitzer, its atmosphere receives charged particles and auroral displays, magnetic storms and radio fade-outs should occur, for they all depend upon the electrical condition of the atmosphere.

The dark hydrogen flocculi or dark markings, as they are otherwise known, are found on all parts of the sun's disc. They represent prominences of moderate height projected against the disc. They too sometimes develop suddenly near complex spots.

From the foregoing, it is natural to suppose that spot-groups with an area of 1,000 or more diminish the solar radiation by an appreciable amount. Such is not the case. The areas involved in these rapidly changing granulations, sun-spots, hydrogen flocculi and other phenomena accompanying sun-spots are so small in comparison with the whole area of the sun that the effect of their variations is rarely more than 0.3 per cent. of the total solar radiation.

The study of the chromospheric eruptions is by no means complete. The results thus far obtained through the co-operative effort of the different observatories show that probably sun-spots are by no means fundamental in the picture of solar variability. They, like chromospheric eruptions and prominences, are the result of some periodically variable, deep-seated effect inside the sun, the exact nature of which astronomers do not yet know.

In view of the fact that sun-spot period is becoming important in numerous fields of scientific activity, much significance attaches to the forecasting of the time and intensity of the next maximum. After the spot minimum early in 1945, the spots of the new cycle increased more rapidly than at similar phases in previous cycles. Such great activity so soon after the minimum gives promise of a high maximum resembling that of a century ago, and the next maximum of sun-spots may be in 1949.

GERMAN WAR RESEARCH AND DEVELOPMENT

III—INSTRUMENTS AND APPLIANCES

Semi-Conducting Materials

A SEMI-CONDUCTING material may be defined as that type of material, the resistance of which does not follow the same general laws as those of metallic resistors. It is also characteristic of them that the heat conductivity is not proportional to the electrical conductivity. Some semi-conducting materials exhibit ionisation and conduction by motions of both electrons and ions in a manner similar to conduction in gases. These are not generally useful for direct current because of polarizing effects caused by the electrolytic part of the conduction. Another class of semi-conductors in which conduction is not accompanied by ionic motions and polarizing effects are also known.

Urdox resistors.—Thermally sensitive resistors were produced in considerable quantities by *Siemens* in Berlin, under the trade name of URDOX. The urdox resistors showed a large change of resistance with change of temperature. The value of the resistance followed a logarithmic law with respect to the inverse of absolute temperature within the prescribed operating range. This range must always be something less than 600° C. and nominally was set at 300° C.

In the manufacture of urdox resistors, finely divided titanium dioxide and magnesium oxide were mixed with water and extruded like any ceramic at an extrusion pressure from 100 to 200 atm. The extruded rods were cut into nibs. They were coated with molybdenum powder on the ends for contact purposes. The material was then baked at a temperature of about 1,000° C. to form a ceramic insulator of extremely high resistance. The insulator was converted into a semi-conductor by subjecting it to a second baking at a carefully controlled temperature in the range of 1,200° to 1,400° C. in an atmosphere of hydrogen or an atmosphere containing hydrogen. The hydrogen reduced the oxygen content of the material, leaving an excess of titanium which caused the material to become semi-conducting. The colour changed from white to black or dark gray in the process.

The value of resistivity of the finished product was dependent first on the percentage

of magnesium oxide present and next upon the heating temperature and time.

In the process of formation of the material, the dielectric constant changes, and this could be used for controlling the forming process.

The molybdenum coatings at the ends of the resistors were copper plated for better contact as a final step in the manufacture.

It is understood that the resistors have no sources of electrical noise within them other than the minimum thermal agitation noise. However, mention was made of some contact noise phenomena.

Uses for the urdox resistors comprised the following:

1. Accurate temperature measurement and control.
2. Voltage regulation and control.
3. Volume controls without noisy sliding contacts.
4. Automatic motor and filament starters.

Thin film resistors.—Considerable work had been done on the development and applications for very thin films and threads of titanium dioxide semi-conducting materials. These have very small heat storage capacity and consequently could be made to exhibit large changes of resistance in response to very small addition or subtraction of energy.

The films were formed by mixing titanium dioxide with a binder such as starch or collodion, which was formed into thin paper-like sheets. These sheets may be bent, cut and mounted as desired. They were then subjected to heat processes similar to those used in making resistors. The binder was removed by the first heating. Films of 30 μ thickness had been made. They were rather fragile after the first firing but improved during the second firing.

The thin films were potentially very useful for measuring incident radiant energy, as in pyrometers and infra-red detectors, not only due to their small heat storage capacity but also due to their blackness or high absorption of all radiation frequencies. They could also be used with fixed input energy to measure gas pressures over a very

large range of values extending down into the range of pressures provided in X-ray tubes.

For any given pressure range, the sensitivity of indication can be made to approach infinity because of the regenerative or dynamic negative resistance effect which can be provided by operating the material with an applied potential which was adjusted high enough. If input energy can lower the resistance to make the input energy increase itself, complete instability of resistance was possible, and actual oscillations of current have been obtained when suitable input power circuits were used. In practice the condition of instability should not be approached too closely.

Proposed applications for thin films and threads comprised:

1. Automatic control of vacuum pumps.
2. Simple and accurate recording of pressure vs. time.
3. Measurement of direction and velocity of flow of gases.
4. Rapid acting simulated pendulums.
5. Pyrometers.
6. Accurate measurement of very small angles (5 minutes per division).
7. Micrometer, sensitivity of 0.1 mm. per division has been attained.

The rapid acting simulated pendulum was of interest; in one form it consisted simply of an electrically heated horizontal wire above which were two parallel spaced titanium dioxide, thermally sensitive resistance threads. All were enclosed in a glass bulb with gas at a suitable low pressure. Gas from the heated wire rose against the force of gravity past the thermally sensitive resistances, determining their relative temperature and, therefore, their relative resistances. Any tilting of the plane of the two elements from the vertical, changed the relative temperatures of the sensitive elements and thereby caused differential resistance changes which may be used to operate an indicating or control system. The device exhibited all the response properties of a pendulum free of swing in one plane, but can respond much faster than a mechanical pendulum.

Electrically controlled clutches.—Many years ago it was demonstrated that the friction between a semi-conducting material and a metal shoe sliding over it could be varied over a large range of values by passing

a variable electrical current through the surface between them. Attempts were made to use the phenomenon to provide electrically controlled clutches, and the clutches did find some use in telegraph signal recorders. The development was abandoned because of the poor quality of semi-conductors then available.

With the development of the new titanium dioxide semi-conductors, the old abandoned development had been revived with much more promising results, because of the relative perfection, uniformity and hardness of the new materials. It has been suggested that electrically controlled friction clutches may very well assume considerable importance in the future. In general, the clutches provide control of mechanical power by electrical power in a manner to give very great amplification and rapid response. For many applications they might replace the Amplidyne or Metadyne control devices which are now in use on a large scale in military equipment and in industry.

Thermal electromotive force of semi-conductors.—Titanium dioxide types of semi-conductors have been found to provide thermal electromotive forces about ten times greater than that of metals and this might lead to important applications.

Electronic amplifiers without vacuum.—The possibility of using thin films or control electrodes in semi-conducting materials to provide control of current flow similar to the control of current flow in high vacuum tubes has been suggested.

Selenium Rectifiers

Amorphous selenium was spread over a metal plate, put under pressure applied with a mica cover plate and baked at a temperature of approximately 200° C. which was still below the melting point. The selenium crystallized at this temperature. A conducting surface may then be sprayed over the selenium. The AEG Co. applied selenium by evaporation in a vacuum and thereby got a consistent reproduction of results.

One good type of selenium rectifier comprised an iron plate covered with a layer of cadmium on which selenium was deposited. This was baked to form a diffused interface between the selenium and cadmium after which an overlayer of cadmium was applied to form an electrode without baking. Overheating this rectifier destroyed its rectifying properties by forming similar cadmium

selenium interfaces on both sides of the selenium.

X-ray studies of the crystalline structure of the selenium indicated that the crystals were formed of long parallel chains of selenium atoms with the length and spacing of chain subjected to variation due to impurities such as iodine. There were defects in the crystalline structure which decreased with long heat treatment. Iodine accelerated crystallization by closing off the ends of chains of atoms. Frozen selenium will crystallize in a few days if contaminated with iodine whereas when not contaminated, it will not crystallize. In rectifiers, iodine of about 0.1 per cent. concentration was used to obtain a more or less optimum condition of crystallization to give the rectifier minimum resistance.

Television and Iconoscopes

Television in Germany was of the 1939 U.S. and U.K. variety. Nothing new in equipment or technique was discovered. Research was continuing on a super-iconoscope using an antimony-caesium photocathode and nickel image plate coated with magnesium oxide. The magnesium oxide was deposited on nickel by placing the nickel plate above a piece of burning magnesium. The storage of an electron image on this plate was said to be good for several hours.

Development of a translucent mosaic such as is used in the orthicon but for high velocity electron beam, was under way but no tubes had been completed.

For motion picture pick up, the Germans made considerable use of the "indirect" or "flying spot" method of scanning. This utilized a C.R.T. with a very short persistent screen (zinc oxide) to produce a flying spot. Electron multiplier photoelectric cells of the antimony-caesium type changed the light intensity variations of the picture into electrical impulses. Because of a slight amount of afterglow trailing the spot, it was necessary to compensate electrically for this by accentuating the high frequencies, a technique long known to improve the horizontal resolution when properly employed.

The short persistent screen tube was also used for photograph transmissions for "quick facsimile" work transmitting a 5" x 7" picture using 300 lines of 2 seconds. The code name for the smaller and more portable type facsimile was "Rudolph." The

equipment required a side band of approximately 50 kc. for optimum fidelity. Experiments in the laboratory over short distances and by wire, had successfully transmitted and received a 2,000-line picture (5" x 7") in 2 seconds. This required a 1 megacycle side band. The resolution was of such a nature that it was difficult to distinguish the reproduced image from the original photograph.

The manufacture of the iconoscopes was practically the same as that employed by other manufacturers in which a good percentage of success depended upon the experience and technique of the fabricators. Distilled nickel was used as the signal plate on the "back" side of a thin sheet of mica. This mica was approximately 0.001" thick. It was kept rigid by a thicker mica backing sheet and placed in a wire framework which was then fastened into the large cylindrical glass form of the tube.

Silver was distilled from two "pots" located approximately 10 cm. in front of and at either vertical edge of the mica. After the vessel was well baked and evacuated, the silver was distilled from these side pots. (The silver in the pot was heated by a tungsten coil.) The correct amount of evaporated silver was dependent upon many factors and in this case they utilized slits in the pots such that a fraction of the silver distilled to the outer glass envelope behind the pots and gave an indication of the total silver evaporated. By experience, they had found that with this particular arrangement, a mirror surface of approximately 1.5 cm. in length on the side walls indicated the correct amount of silver distilled on the clean side of the mica. The silver layer was then caused to break up or "crack" and form individual and fairly uniform globules of microscopic size. This was accomplished by baking at approximately 350° C. for about 15 minutes and gave an approximate silver coverage of 40 to 50 per cent.

Oxygen was admitted into the vessel and ionized by means of a coil carrying radio frequency currents. The coil was moved about externally and made it possible to control the ionization inside the tube quite readily. Care must be exercised to avoid excessive glowing at the mosaic plate or points in close proximity to the mosaic if a uniform surface was to be realized. The degree of oxidation can be observed by the change in colour (interference pattern). The

oxide layer formation was carried to the first purplish state. The tube was again evacuated and the cathode formed in the conventional manner.

Caesium was then admitted, being distilled from caesium chromate contained in an aluminium capsule. During the caesium admission, the photo emission from the mosaic was checked to determine when the proper amount of caesium had been admitted. The tube was baked at approximately 180° C. during this process. When sufficient caesium had been admitted, and the tube baked to the maximum photoelectric sensitivity, it was taken off the pump. It was then checked for sensitivity, resolution, etc., while under operating conditions. In the event of insufficient sensitivity requiring more caesium, the tube was sealed back on the pump and additional caesium admitted. Arrangements were made for replacing the tube back on the pump as many times as was desirable. This process was repeated until sufficient sensitivity and resolution were obtained. The final seal off was then made. Such a process was not applicable to large-scale production.

Silver was distilled in the final phase while observing a picture as being produced by the iconoscope to obtain the correct colour response and improve the sensitivity. Where excessive amounts of caesium had been admitted into the mosaic, the introduction of oxygen for a short period of time, while the tube was in operation to permit visual observation and control of the process, could be employed to produce a good mosaic. However, such procedure required caution as the cathode could be spoilt very easily.

The German iconoscopes operated normally with 4 volts on the filament and 1,000 to 1,200 volts on the second anode. High voltage was obtained from the horizontal deflecting circuits, utilizing the high induced voltage during the flyback time of the saw tooth.

A 441-line, 25 pictures per second television system of fair quality, using both large and small iconoscopes, had been developed. The smaller tube had fair possibilities for commercial production. Contrast in outdoor scenes in sunlight was very good using an F3 lens. Remote focus control introduced considerable microphonics into the picture. Periodic line displacement (tear out) was present and interlacing was paired and fluctuating. Line surges also introduced

considerable interference in the picture. Apparently the installation was set up mainly for testing the sensitivity and resolution of iconoscopes.

Electron multipliers.—Development had been carried out on two types of multipliers. The one employing the familiar "Weiss" plane grid type of construction, the other a system of successive plates as developed by Zworykin. Both types employed purely electrostatic constrain of the electron beam. The Weiss type had been used only with photo cathodes whilst the Zworykin had been developed to use both photo and thermionic cathodes. Secondary emitter surfaces were of a silver-magnesium alloy, the percentage of magnesium being 1-3 per cent.

Infra-Red Developments

The Germans had devoted considerable effort to I. R. development and were definitely ahead of the Allies. The use of I.R. equipment was limited in the day-time.

The spectral region which comes into question is from about 0.8 μ to 15 μ . In comparison with radar frequencies, water vapour absorption and water particle scattering cause considerable difficulties.

Practical applications may be arranged under three groups:

(1) Communications, in which a transmitter and a receiver were used at separate places and both equipments were used intentionally.

(2) D. F. uses, in which information was obtained from the I. R. emitted by the target.

(3) D. F. uses, in which a transmitter was located at the receiver, information being obtained by reflection from the target.

(1) Communication may use either speech-modulated signals, or simply on/off switching. I. R. searchlights with a beam spread of about 8° were made, so that slight relative motion of the equipments would not cause a break in transmission. An I. R. filter was used to prevent a visible beam being transmitted, and either telephony or telegraphy was used.

(2) Receiving apparatus for D.F. was much the same whether a transmitter was being used or not. Either a picture of the region covered was obtained on the screen of a cathode ray tube, or only a very small area was observed, which made accurate D. F. possible, or a large area was observed

and scanned inside the receiver to have many of the advantages of the other two.

(3) The advantage of this was longer range and no betrayal of the position of the searching apparatus; it was of considerable use against the hot gases from airplanes and ships. One disadvantage was the difficulty of range-finding, and investigations on this were proceeding.

The useful frequency range was limited by the properties of the receiving elements and besides the transparency of the atmosphere, by the "Storstrahlung" or I. R. noise of unknown origin. A research programme into the relation of this effect to the weather and frequencies present was planned.

Sources.—(1) Hot Radiators.—Both types used for this purpose produced almost black-body radiation, and both types had been developed up to about 40 k.w.

(a) Arc Lamps. The carbon arc has a temperature of about 4,200° K, and may be used for a wide band of frequencies. The Beck-arc with a temperature of 5,500° K was also used.

(b) Filament Lamps. Tungsten lamps have a temperature of only 2,800° K; the glass envelope may filter out the I.R. frequencies desired. They were only used for small installations.

(2) High Pressure Lamps.—The mercury vapour lamp was the most developed; water-cooled quartz lamps with a pressure up to 200 atmospheres had been produced.

Filters and mirrors: Filters.—These were used to prevent unwanted radiation from transmitters, and to prevent unwanted reception. *Zeiss and Schott u. Genossen* had produced many types; one filter believed to contain lithium fluoride had a permissivity of 70 per cent. upto 7 μ . For windows, either quartz or "Duranglas," made by *Schott u. Genossen*, was used.

Mirrors—Ordinary glass strongly absorbed I.R., so that a front surface mirror must be used. At first a vacuum-vaporized rhodium mirror was used, but this tended to become loose from the glass. Recently only the "Hochheimverspiegelung" process of *I.G. Farben* had been used. This produced a high vacuum evaporized aluminium layer, which was then coated with a special lacquer transparent to I.R.

Empfangsorgane (I.R. Receiving Elements):

—Photoelectric Cells.—Caesium cells were used for the 1 μ region; these depend on the external photoelectric effect and so could be

used in electron-optical systems. This also applied to thallium-sulphide cells, which had the disadvantage of using the inner photoelectric effect (i.e., received radiation caused a change in the inner resistance of the substance).

Lead sulphide cells, also using the inner effect, reach to 3.8 μ . On cooling the lead sulphide to about 80° C., the sensitivity was increased twenty times. This was done by keeping the layer in a vacuum container and cooling it with solid carbon dioxide. A voltage of 50 to 300 volts was applied.

Further development was intended to use the region from 3.4 μ to 4.3 μ where radiation was little absorbed by water vapour. In particular, lead selenide cells similar to the lead sulphide cells show considerable promise. Lead telluride cells would reach even longer wavelengths.

Thermal receivers such as bolometers and radiometers were not frequency-dependent. However, absorption by water vapour precludes wavelengths above 13 μ and makes the range 8 to 13 μ unsuitable. Under comparable circumstances, receivers fitted with bolometers and lead sulphide cells had about the same range. High resistance bolometers were being developed. One of these used copper oxide about 10 μ thick, prepared from evaporized copper. Four of these were arranged as a Wheatstone Bridge, the radiation falling on one only. The complete bridge was mounted on a disc about 3 cm. diameter. Another model had twenty sensitive points arranged in a line about 2 cm. long on a disc about 2.5 by 2 cm.

Bildwandler (I.R. Picture producers).—Electro-optical.—Screens for producing a visible picture from received I.R. rays usually had a sensitive element, a Cs-Cs-O₂-Cs cathode on a silver base. An electron-optical system focussed the emitted electrons into a C.R.T. screen.

I.R. Photography:—Photographic Materials.—A bromide silver emulsion is sensitive mainly to blue, violet and ultra-violet; for panchromatic photography various dyes are used which have long polymethylene chains between heterocyclic rings. The frequency at which the dye is effective depends on the length of the chain.

Aesfa had produced photographic plates on this principle sensitive up to over 1 μ ; long exposures had enabled spectral lines up to 1.36 μ to be photographed. One difficulty

was that these emulsions were very unstable, but if stored at low temperatures would last for several months.

Radar

From 1939-42, it was forbidden in Germany to work on frequencies above 300 mc/sec. In 1943, when the Allied radar was found to be so successful against U-boats, this restrictive policy was abandoned.

The Germans attempted to copy closely the radar equipment captured from the Allies; they were very much behind the Allies in radar developments.

Most of the German centimetre tube development had been in the *Telefunken Tube Research Laboratories*.

The first 10 cm. equipment, "Rotterdam", was operational between June and December 1944. Since then, further marks of this and also "Berlin" and "München" had been developed. The magnetron used, LMS 10, was a copy of the Allied one. The 3 cm. magnetrons were claimed to be of German development. LMS 10 was 30 per cent. efficient. LMS 100 up to 100 kw., also on 10 cm. was 10 per cent. efficient and had a field of 1,500-2,000 Gauss, 30 per cent. greater than critical. It was air-cooled. Small magnetrons developed were of about 13 types. Copper magnetron anodes were used only recently. Most of the tunable magnetron work was done on 3 cm.

The Klystrons developed by the *Telefunken* were 3 cm. all metal. They were experimenting with $1\frac{1}{2}$ cm. reflected beam tubes.

Several types of ceramic and metal grounded grid triodes had been made. A 10 kw. peak power was obtained with a space/mark 5 to 10.

Experimental 10-cm. pulse transmitter.—The ideally simple way of providing the very short pulse trains used in radar was considered to be the simple spark gap device. A peak of several kw. at 200 megas. had been provided from a simple gap with 3,000 volts at atmospheric pressure. Owing to the very high damping due to the gas at these frequencies, the wave train lasted only for about $1/30$ micro sec. resulting in too low an average power to be useful and too great a frequency spread. The excessive damping was due to too great a deionization time in the gap, and the most promising remedy was to employ a hydrogen gap at high pressure. This was actually tried by the Germans, and an experimental gap in

series sections (similar to the old "quenched gap") in hydrogen at 10 atm. had proved successful. The device called "Fips" gave a 1 kw. output peak at 10 cm. wavelength. Each gap had to be accurately machined. The only trouble was the very short life, only about 5 hours. The frequency spread was said to be longer than desirable.

Dr. Dohler (late of Hamburg University) had developed a spark gap transmitter working reasonably well down to a wavelength of 60 cms. In some respects, the pulse transmitters were simpler than those employing the valve technique. The sparking elements were of copper as it was the only metal that gave a reasonable life against burning (40 hours). To reduce the damping due to the spark, a condenser was put in parallel directly across the gap. At 80 cm. wavelength, the resulting spectrum could be reduced in width to 1 per cent. of the frequency.

The R.F. circuit was completed by connecting across the gap a small condenser (about 8 p.f.) in series with a small variable inductance (concentric lecher wire). The H.T. supply was a 50 cycles A.C. directly from the secondary of a transformer having a small resistance in its primary to avoid overload on peak currents. In this way a very high repetition rate was achieved. The rate was variable throughout the 50 cycle period rising to about 600,000 per sec. at the peak of the applied voltage (3,000 v.). An average power of 40 w. was obtained. The peak power was said to be 5-10 kw.

For possible radar use, where normally quite a low p.f. was required, neither the overall average power efficiency nor the deionization time was of prime importance. Tungsten electrodes in nitrogen at 50 atm. were, therefore, employed, giving a longer deionization time but much longer life to the gap electrodes. In other respects the apparatus was the same as before, except that only one gap element was used and the device adjusted to give only 1 pulse per half period of applied voltage (sinusoidal as before). The gap length was P1 mm. A peak power of 10 kw. was obtained at 60 cms. at 100 p.r.f.

Pulse transmitter megnetrons.—Attention was diverted to tubes for $\lambda=3.15$ cm. and subsequently to shorter wavelengths. Tubes were produced giving 15 kw. at 3 cm. for an input of 300 kw. and also 10 kw. at $\lambda=1.75$ cm. for an input of 400 kw. The

tubes were made of nickel-iron alloy (50:50) with an interior block of vacuum copper.

Muller Kostas pulse transmitter tubes were based on the theory of oscillation in an electron beam traversing a single cavity without a reflector or means of back-coupling. The tube resembled a reflector klystron with a long electronic path inside the cavity and the reflector strapped to the cavity wall. Difficulty was experienced in finding cathodes with sufficient emission and attempts were made to overcome this by putting two cathodes, one at each end of the cylinder, both firing electrons into the cavity through gratings in the end walls. One tube gave 4 to 6 kw. at $\lambda=3.15$ cms. from inputs of 12 a at 8 kv. or 9 a at 17 kv. but most tubes gave much lower outputs.

Projection tubes.—The average life of German-made projection tubes was approximately 100 to 200 hours. The voltage normally applied to these tubes was about 60 kv. It was believed that the formation of gas was the limiting factor in the life of a tube as the gas ionization destroyed the emission of the cathode. The gas was evolved from the thin film of collodion or paraffin which was used to form the film of fluorescent materials.

A brightness variation of 50 to 1 was said to be obtainable with these tubes with a spot size change in diameter of 2 to 1. It was necessary to reduce the brightness of the spot with the age of the tube to maintain a fairly constant spot size.

Experiments had progressed on both air and water-cooled screens, with a slightly higher voltage beam usable for water-cooled type. For high intensity projection tubes, it was necessary to increase the conductivity of the fluorescent material to prevent a large potential from building up on the screen. To do this, a thin layer of aluminium was distilled over the fluorescent material. In practice, aluminium was distilled in the tube until it just formed an opaque film on the glass walls of the tube. Aluminium alone was not sufficient to form a good conducting layer and it was necessary to cover the screen material with a thin layer of paraffin or collodion. This gave the aluminium a smooth surface to form a continuous film on. During the aluminium distillation it was necessary to keep the screen cold with CO_2 or liquid air to prevent the vaporisation of the paraffin or collodion.

After the aluminium was distilled, the tube was heated to approximately 360°C . to remove as much excessive paraffin as possible. Tubes without the paraffin aluminium layer had a greater life but could not be used at the higher potentials.

When using a "Fernico" or "Kovar" metal plate as a base for the screen as in water-cooled tubes, it was essential to plate the metal with chromium to prevent the screen material from reacting with the "Fernico". Such reaction produced screen discoloration with resultant loss in illumination.

Fluorescent materials.—The use of zinc sulphide and zinc selenate for cathode ray tube screen powders resulted in screens which were claimed to be more stable, more resistant to electron burn and more resistant to chemical poisoning during processing. The method of preparing screen powders was also novel.

The powders were heated in an atmosphere of nitrogen at 900°C . under a pressure of 200 atmospheres.

Long persistent screen.—Potassium chloride (KCl) was deposited on a thin sheet of mica or glass upon which a thin film of tungsten or chromium had previously been distilled. The scanning rate of the electron beam at a potential of 10 to 15 kv. was approximately 10 to 20 m. per sec. Light was projected through the KCl screen which changed its degree of opacity in accordance with the beam variations in intensities. The image would normally last about $\frac{1}{2}$ to 1 hour.

The image could be removed by heating the screen to $350^\circ\text{--}400^\circ\text{C}$. for about 10 seconds. The screen must cool for approximately two minutes before another image could be reproduced on it. Below a potential of 10 kv. the change of opacity of this type of screen was negligible. The screen temperature could be controlled electrically in those types which had a thin metal film; otherwise it required external heating.

Time modulation.—The transmitter was required to send only pulses. The field strength modulation depended on the interval between the pulses, the impulse frequency being subjected to modulation. On the receiver side, it was possible to employ limiters and gate valves. Rectification was effected by normal audio stages, the number of pulses being integrated. In order to eliminate interference, the single pulse was converted into a triple pulse by a time delay

network on the transmitter side and the interval between the pulses served as a key. The receiver was also fitted with a time delay network and the gate valve only opened with the coincidence of the three pulses, these having arrived at the correct intervals. The receiver would thus receive only properly spaced triple pulses. It was possible also to provide multiple reception by transmitting several messages through the same high frequency channel with different pulse spacings. In this case, it was only necessary to use several gate valves (or coincidence tubes) after the delay circuit. The triple impulse rendered the system extremely free from interference. An impulse frequency of $6,000 \pm 1,500$ c/s was employed and the impulse frequency was swept at a rate of 300-2,500 c/s determined by the audio-frequency wave form. The radio frequency was in the band 2.5-4.0 metres.

The F.M. generator consisted of a frequency modulated oscillator of fundamental frequency about 1 mc. with a maximum frequency range of 10 kcs. and a stable oscillator whose frequency could be set at 6, 8 or 15 kc/s. from the frequency of the first oscillator. By superposition, a carrier frequency of 6, 8 or 15 kc/s was produced having a maximum frequency range of 10 kc/s. This carrier was filtered, amplified and converted into a pulse of approximately 2 micro seconds by the action of an appropriate tube of the impulse generator. This pulse was produced in the oscillatory circuit by the differentiation of the anode current in the second stage.

The pulses were received in the receiver in the normal manner, demodulated, subsequently amplified and decoded. The decoding tube was insensitive to any pulse, but responded by emitting a single pulse upon receiving a definite group of three pulses set at the delay circuit. From the series of pulses thus generated, the fundamental wave was extracted, limited and demodulated followed by low frequency amplification.

Crystal detectors.—Germanium was used instead of silicon, because its lower m.p., 960°C ., instead of $1,500^{\circ}\text{C}$., allowed easier handling. The idea was to produce single crystals. Germanium deposited by rapid cooling of the vapour had been tried and found useless. The best crystals were not as good as silicon crystals, but they were much more uniform.

A process of making synthetic crystals for frequency control had been developed by *Telefunken*. The crystals were grown in an autoclave at 400°C . and under a pressure of 375 atmospheres. The process took two weeks.

Antenna Systems

The "Wullen Weaver" antenna system: The Antenna Research Station belonging to the "Kriegsmarin" establishment had developed a semi-experimental antenna of considerable interest. It was a broad band, 15-50 m. system capable of giving a beam between 10° - 35° width depending on the wavelength, capable of being rotated electrically to receive from every direction.

There were 40 vertical wide band antenna elements, equally spaced at about $\frac{1}{2}$ wavelength (middle of the band) from each other round the circumference of a circle. Inside the circle of antenna elements, there was another concentric circle of about $\frac{1}{2}$ wavelength (wave band centre) shorter in diameter, of closely spaced iron wires (vertical) of about the same height as the antenna elements. The reflective power of the iron wires was said to be very small. They acted as screens preventing back receptions. Each antenna element which was 7.5 m. high was broad-banded, each element consisting of a closely spaced stack of vertical conductor wires arranged to form the surface of a vertical cylinder with a conical nose where all the wires were joined at the bottom end. Near the top end of the stack, a wheel was provided of which the spokes were wires radiating from a point on the cylindrical axis. The plane of the wheel was horizontal. Each antenna was fed by a 50 Ohm. concentric line connected directly to the low impedance point at the junction of the cylindrical base. The 40 separate concentric lines terminated in a central hut, where a capacity switched device was installed to use together any of upto 12 adjacent antenna elements. Elements of a delay line were automatically switched in when the elements were connected. The delay line elements conformed to a law of delay such that either

- (a) the whole antenna structure had substantially a single lobe diagram of 30° - 35° width (depending on the wavelength), or
- (b) an overlapping bi-lobular diagram suitable for direction finding.

The cut-off of the delay line was between 5 and 6 m., so that it was suitable for the whole wave band covered.

RECTIFIED SPIRIT AS FUEL FOR MOTOR VEHICLES

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Introduction

IN the United Provinces, fuel alcohol, which is another name for denatured rectified spirit, is used to some extent as a substitute motor fuel in place of petrol. The United Provinces is fortunate in having a large sugar industry and it is natural to utilize waste molasses for the production of fuel alcohol. Previously fuel alcohol had been little used in India for motor vehicles. In European countries, fuel alcohol was largely used but always mixed with some more volatile fuel. The all-round lower temperatures in those parts make it difficult to use alcohol as such without some permanent auxiliary starting device. In India, on the plains at least, temperatures are sufficiently high during the major part of the year to ensure easy starting with alcohol.

Apart from operational troubles which are comparatively easy to overcome, the chief deterrent to wider use of alcohol is the cost of operation. The price per gallon of spirit in the United Provinces is an anna or two higher than that of petrol. But owing to its inherently low calorific value the mileage per gallon of spirit is low compared to that of petrol. Material reduction in the price of alcohol will need large-scale measures. An immediate and reasonable step will, however, be to reduce the tax per gallon of fuel alcohol so that it bears the same proportion to the tax on petrol as do the mileages obtained per gallon to one another. This question of tax remission was raised by the U.P. Government, but reliable figures for the comparative mileages were not available. A programme of road trials was, therefore, initiated. Incidentally, some problems connected with operation of vehicles on rectified spirit were also studied.

Vehicles Used in the Trials

Two vehicles, both belonging to the War Transport Department, were employed. One was a new Lease-Lend 160" wheelbase, 3-ton, 1943 model Chevrolet truck, which was being used for departmental trials on producer gas reliability and performance. It had covered about 5,000 miles, mostly on

gas, at the time of these tests. The other was a station wagon built on a Ford V8, 1941-model, 122" wheelbase, 1-ton truck chassis. It had covered about 35,000 miles at the time of tests, mostly on gas. It had been reconditioned once at about 24,000 miles and was generally in good condition except for the gear box which had a tendency to disengage when in middle gear.

Conversion for Operation on Spirit

So far as is known, no uniform or rational procedure seems to have been adopted for conversion of engines from one fuel to another. Before attempting the conversion it was, therefore, considered necessary to examine the properties of petrol and rectified spirit, as obtained from the literature and from laboratory experiments. On the strength of these data, a suitable method could be adopted and an estimate of the probable mileage ratio of spirit to petrol could be made. The results are given in Table I.

TABLE I. *Comparative Properties of Petrol and Rectified Spirit.*

Particulars	Spirit 95% by volume	Petrol
Specific gravity at 60° F.	0.816	0.739*
Viscosity in centipoises at 30° C.	1.175	0.402*
Total heat for complete evaporation at 760 mm. from 0° C. Cal./gr.—	255 (for 100% alcohol)	138
Vapour pressure in mm. of Hg.—		
at 30° C.	77	145 to 185
at 10° C.	24	70 to 90
Net calorific value, B.Th.U. per gallon	87,230	139,700
Theoretical quantity of air required for complete combustion in lbs. per lb.	8.4	14.3
† Indicated thermal efficiency in %. at compression ratio of—		
3.8:1	26.8	26.3
5.0:1	32.5	31.7
7.0:1	38.2	37.4

* These values were experimentally determined for the generally available leaded and red-dyed petrol.

† These figures are taken from *Power Alcohol* by G.W. Monier-Williams, 1922, Chapter IX, p. 250.

Assuming conditions of operation such as load, speed, etc. to be the same in both

the cases, the mileage obtained per gallon of fuel will be directly proportional to the product of calorific value and thermal efficiency. Taking figures of Table I, ratio of mileage per gallon of spirit to that on petrol is found to be 64.0 per cent. and 63.8 per cent. respectively for compression ratios of 5.0:1 and 7.0:1. As all motor vehicle engines have compression ratios within this range, a mean mileage of 63.9 per cent. may be taken as the probable value that can be expected. The rate of flow of spirit to the engine has accordingly to be 1.56 times that of petrol. It is clear that the carburettor has to be modified to permit this increased flow. For maintaining the correct level in the float chamber, the greater specific gravity of spirit will require that the float be weighed in proportion to the specific gravity.

The required increase in the cross section area of the carburettor jet will depend on the shape and dimensions of the main jet and other fuel passages, the nature of flow through the passages, etc. If it is a simple case of capillary flow then the greater viscosity of spirit compared to petrol requires that the spirit jet area must be about 2.1 times the petrol jet area to give the requisite rate of flow ratio of 1.56. The first set of trials showed that such increase of area gave, if any thing, insufficient flow of spirit in the case of the Chevrolet engine and excessive flow in the case of the Ford engine. A series of theoretical calculations were then made taking account of the detailed dimensions, shape, etc., of the fuel passages of the two carburettors, with the object of evolving a standard method for calculation of requisite jet areas for any type of carburettor. As a result, it appeared that a much larger number of carburettor types will have to be studied for the purpose, if it was desired to obtain a complete picture. Theoretical calculations were found to be involved by reason of a number of unascertainable variables, and, when certain simplifying assumptions were made, they failed to tally with experimental results. They have, therefore, not been reproduced here. In these series of trials, therefore, the results of a particular trial were used to effect the necessary modification in the succeeding trial, and by this procedure it was found that jet area had no influence on mileage ratios obtained from the two fuels, but did affect maximum power output to some extent.

Trial Procedure

Each set of trials usually consisted of preliminary short runs followed by long runs. First a particular size of jet was fitted and the float duly weighed and a short level-road run of 20 to 25 miles was made. A similar short run was also made on petrol with the normal petrol carburettor under the same conditions of load, speed, etc. Then two long runs were made with spirit and petrol under similar conditions. The long runs were made on the same route as was being used for reliability and performance trials on producer gas. This route is divided into three sections. The first section is practically level road between Delhi and Roorkee, and consists of about 100 miles clear run and 20 miles of city run mostly inside Delhi, or a total of about 120 miles. The second section is from Roorkee to Rajpur Gate on the Mussoorie road and back to Roorkee, a distance of about 105 miles, of which about 50 miles consists of roads having more or less steep gradients. The third section is from Roorkee to Delhi and is the same as the first. In the first and third sections the vehicles were loaded to their maximum permissible limits, namely, 14,600 lbs. in the case of the 3-ton truck and 6,500 lbs. in the case of the station wagon. On these sections acceleration, maximum speed and fuel consumption tests were made. In the second section, the vehicle weights were reduced to 11,800 lbs. and 5,900 lbs. respectively. In this section acceleration, hill climb and fuel consumption tests were made. Vehicle speeds were maintained at 30 m.p.h. and 40 m.p.h. respectively for the truck and station wagon as far as traffic conditions allowed. Atmospheric temperature and relative humidity were observed at intervals during each day of test. Vehicle weights were adjusted by Avery portable wheel weighers which were checked against the weighbridge at the municipal terminal tax station at Jumna Bridge, Delhi. All fuel measurements were made by a standard gallon measure, any fuel taken from pumps by the wayside being checked against it. Samples of spirit from each day's run were taken and examined for concentration.

The first set of trials were with the 3-ton truck. The second and third trials were with the station wagon, each trial comprising spirit and petrol runs. The fourth trial was on the truck with spirit only.

Results of Long Runs

TABLE II. 3-ton Chevrolet Truck : Spirit jet area/Petrol jet area=2.2

No.	Particulars	Petrol			Spirit		
		Section 1	Section 3	Section 2	Section 1	Section 3	Section 2
1	Date of test	Sept. 12, 1945	Sept. 14, 1945	Sept. 13, 1945	Sept. 18, 1945	Sept. 20, 1945	Sept. 19, 1945
2	Strength of spirit, % by Vol.	—	—	—	95.7	95.7	95.7
3	Mean daily atmospheric temp., °F.	81.0	83.5	78.0	87.0	84.0	80.0
4	Mean daily relative humidity, %	97.5	85.0	88.5	69.0	82.0	89.0
5	Distance covered, miles	121.3	125.8	102.7	120.1	117.5	102.3
6	Weight of loaded truck, lbs.	14,600	14,600	11,800	14,600	14,600	11,800
7	Fuel consumed, gallons	10.73	10.96	10.28	15.89	15.82	14.11
8	Mileage per gallon	11.3	11.5	10.0	7.56	7.43	7.25
9	Ton-miles per gallon	73.7	74.8	52.6	49.3	48.5	38.2
10	Ton-miles of pay load, per gallon	43.4	44.0	25.9	29.1	28.6	18.8
11	Mean time to accelerate from 0-25 m.p.h. using all gears, seconds		37.4	32.2		41.8	39.6
12	Time to climb 284.1' from mile 153-6, to mile 154-7, seconds	—	—	243	—	—	256
13	Time to climb 141.1' from mile 155-7, to mile 156-4, seconds	—	—	154	—	—	155
14	Maximum speed, m.p.h.	—	—	—	Over 45		
15	Mean power ratio, spirit to petrol, by hill climb test	= 97.1 per cent.					
16	" " " " " " " " acceleration tests	= 85.6 " "					
17	Ratio of average mileage, spirit to petrol per gallon	67.6 " "					

TABLE III. Ford Station Wagon, Spirit jet area/Petrol jet area=2.0

No.	Particulars	Petrol			Spirit		
		Section 1	Section 3	Section 2	Section 1	Section 3	Section 2
1	Date of test	Oct. 3, 1945	Oct. 5, 1945	Oct. 4, 1945	Oct. 8, 1945	Oct. 10, 1945	Oct. 9, 1945
2	Strength of spirit	—	—	—	95.7	95.7	95.7
3	Mean daily atmospheric temp., °F.	82.0	88.5	82.5	88.5	88.0	86.0
4	Mean atmospheric relative humidity, %	64	47	59	49	50	55
5	Distance covered, miles	123.8	126.3	104.3	124.8	123.0	104.5
6	Weight of wagon, lbs.	6,500	6,500	5,900	6,500	6,500	5,900
7	Fuel consumed, gallons	8.22	7.74	7.34	14.70	12.83	11.01
8	Mileage per gallon	15.1	16.3	14.2	8.50	9.59	9.49
9	Time to accelerate from 0 to 30 m.p.h. using low and middle gears, seconds	—	13.5	12.9	—	12.9	12.2
10	Time to climb 139.8' from mile 153-6 to 154-2, seconds	—	—	66.0	—	—	63.0
11	Time to climb 88.6' from mile 154-4 to 154-7, seconds	—	—	48.2	—	—	50.0
12	Time to climb 141.1' from mile 155-7 to mile 156-4, seconds	—	—	104.0	—	—	99.6
13	Maximum speed, m.p.h.	Over 50			Over 50		
14	Mean power ratio by hill climb tests	= 102.6 per cent.					
15	" " " " acceleration tests	= 105.2 "					
16	Ratio of average mileage, spirit to petrol	= 60.0 "					

Discussion

Against an expected mileage ratio of 63.9 per cent., the first set of trials (Table II) on the Chevrolet truck with a spirit jet having twice the area of the petrol jet gave

a mileage ratio of 67.6 per cent. When the trials were repeated (Table V) with a spirit jet equal in area to the petrol jet, but using the choke control, the mileage ratio was 65.7 per cent. With the station wagon with

TABLE IV. Ford Station Wagon, Spirit jet area/Petrol jet area=1.70

No.	Particulars	Petrol			Spirit		
		Section 1	Section 3	Section 2	Section 1	Section 3	Section 2
1	Date of test	Nov. 12, 1945	Nov. 14, 1945	Nov. 13, 1945	Nov. 8, 1945	Nov. 10, 1945	Nov. 9, 1945
2	Strength of spirit	—	—	—	96.0	96.2	96.1
3	Mean daily atmosphere temperature, °F.	82.0	77.5	74.5	87.0	82.0	76.5
4	Mean relative humidity, %	42.0	49.0	52.0	39.0	47.0	61.0
5	Distance, miles	113.1	110.3	107.2	113.7	109.0	104.8
6	Weight of wagon, lbs.	6,500	6,500	5,900	6,500	6,500	5,900
7	Fuel consumed, gallons	7.00	6.43	7.08	11.85	11.00	11.41
8	Mileage per gallon	16.16	17.20	15.14	9.60	9.91	9.20
9	Time to accelerate from 0 to 30 m.p.h. using low and middle gears, seconds	12.9		12.4	13.2		12.5
10	Time to climb 139.8' from mile 153-6 to 154-2, seconds	—	—	67.0	—	—	60.0
11	Time to climb 88.6' from mile 154-4 to 154-7, seconds	—	—	45.6	—	—	48.5
12	Time to climb 141.1' from mile 155-7 to 156-4, seconds	—	—	103.0	—	—	103.0
13	Max. speed, m.p.h.	Over 50			Over 50		
14	Mean power ratio, spirit to petrol, by hill climb tests	= 101.9 per cent.					
15	Mean power ratio, spirit to petrol, by acceleration tests	= 98.5 "					
16	Ratio of "average" mileage, "spirit" to petrol	= 59.3 "					

TABLE V. 3-ton Chevrolet Truck, Spirit jet area/Petrol jet area=1.00

Carburettor air inlet closed by choke control as required. Carburettor float not weighted.

No.	Particulars	Petrol			Spirit			Position of choke control
		Section 1	Section 3	Section 2	Section 1	Section 3	Section 2	
1	Date of test	Nov. 27, 1945	Nov. 29, 1945	Nov. 28, 1945	Nov. 27, 1945	Nov. 29, 1945	Nov. 28, 1945	
2	Strength of spirit, % by volume	—	—	—	96.1	96.1	96.1	
3	Mean daily atmospheric temp., ° F.	—	—	—	74.5	78.0	69.0	
4	Mean daily atmospheric relative humidity, %	—	—	—	43.0	39.0	55.0	
5	Distance, miles	These figures for petrol were not obtained during this trial. Comparisons were made with figures for petrol in Table II.			121.7	125.4	104.9	Choke about half closed.
6	Fuel consumed, gallons				16.91	17.46	14.63	
7	Mileage per gallon				7.20	7.19	7.17	
8	Ton miles per gallon				46.9	46.8	37.8	
9	Ton miles of pay load per gallon				27.7	27.6	18.6	
10	Weight of truck, lbs.	14,600	14,600	11,800	14,600	14,600	11,800	
11	Mean time to accelerate from 0 to 20 m.p.h. using all but top gears, seconds	20.2	20.7	17.6	26.7	29.8	24.3	Choke fully closed.
12	Time to climb 284.1' from mile 153-6 to mile 154-7	—	—	221.0	—	—	225.8	
13	Time to climb 141.1' from mile 155-7 to 156-4	—	—	142.8	—	—	151.0	
14	Max. speed, m.p.h.	Not taken			Over 39			—
15	Mean power ratio, spirit to petrol, by hill climb tests = 96.3 per cent.							
16	" "							

spirit jet area 2.0 and 1.7 times petrol jet area, the mileage ratios were respectively 60.0 per cent. and 59.3 per cent. For each vehicle, there appears to be fair agreement in the figures for mileage ratio irrespective of jet size. The mean ratio for all the four trials on the two vehicles with varying jet size came out to be 63.2 per cent. as compared with theoretical expectation of 63.9

per cent. As long as the spirit jet is not so large as to cause unnecessarily rich mixtures and is not so small as to give insufficient power to drive the vehicle with test load at test speed, it might be expected that mileage ratio will be roughly the same for a particular vehicle. The discrepancy between the mileage ratios for the truck and the wagon means that under the conditions of test the

wagon was, for some reason, unable to use spirit as efficiently as the truck.

The trials on the station wagon showed that it was possible to obtain slightly more power with spirit using a bigger jet than with petrol using normal jet. Though there is better agreement between power measurements by hill climb and acceleration tests in the case of the station wagon than in the case of the truck, measurement of power by the hill climb test is not considered satisfactory in the case of the wagon because the gradients were not steep enough and full throttle could not be employed at all times, especially at the several sharp bends on the steep road. The discrepancy in the figures for power by the two methods in the case of the truck may be due to better vaporization of spirit under steady conditions of operation obtaining during continuous climbing as compared to varying conditions obtaining during acceleration and gear changing. In all the tests the maximum speeds obtained showed that there was sufficient power reserve. In the second test on the truck (Table V) the power increased more and more as the choke was pulled and was maximum when the choke control was fully pulled out, all the air required by the engine passing in that case through the small opening of the spring loaded choke plate actuated by the suction of the engine. Ordinary driving required the choke to be pulled out half-way only, but rapid acceleration required pulling out the choke control completely.

Performance on spirit was quite satisfactory on long runs. Short runs with frequent starts and stops as in city driving, were not so satisfactory. This was due firstly to a slight lag in the pick up on depressing the accelerator pedal and secondly frequent stalling of the engine when depressing the clutch, despite best idling adjustment. However, this trouble was noticeably absent in the last trial on the truck in which choke control was used. In this case, though a slightly higher idling speed had to be used, city driving was quite comfortable. At an

atmospheric temperature of 65° F. neither the truck nor the wagon engines could start from cold and a small quantity of petrol had to be used. At 73° F. starting from cold was easy. At low temperatures some hot water could be poured on the intake manifold system to facilitate starting with alcohol.

Conclusions

(1) Using the generally available leaded and red-dyed petrol and about 96 per cent. by volume of rectified spirit, the ratio of mileage on spirit to petrol may be taken as varying from 60 to 68 per cent. depending on the type of vehicle, operating conditions, etc.

(2) Any desired power upto slightly more than normal petrol power could be obtained with spirit by using suitably adjusted carburettor jet.

(3) The size of carburettor jet to be used will depend on the type of carburettor and desired power output. A useful criterion to follow may be to use the minimum size of jet that will give approximately 90 to 100 per cent. of the power on petrol. On this basis, for Chevrolet truck the main jet area may be increased by a factor of 2.0 to 2.2 and for Ford by 1.5 to 1.7.

(4) On some engines, it may be convenient to use the petrol carburettor without any modification for spirit operation and obtain necessary increased flow of spirit by using the carburettor choke control. By this means the maximum available power will be appreciably less than petrol power but will be ample for most purposes.

(5) Special starting arrangement such as heating the carburettor and intake system or providing alternate petrol supply will be required when atmospheric temperature falls below 70° F.

(6) For satisfactory driving under all conditions through city traffic with frequent stops and starts the idling performance has to be improved. Enlarging the idling jets may help.

Obituary

SIR UPENDRANATH BRAHMACHARI, M.D., Ph.D., F.R.A.S.B., F.N.I.

WITH the death of Dr. Sir Upendranath Brahmachari on 6th February 1946, India has lost one of the most outstanding personalities in the field of scientific medicine. Sir Upendranath had a unique career, both academic and practical. His knowledge of basic sciences combined with his practical grasp and mastery of clinical medicine put him in a decidedly advantageous position over his contemporaries in his researches in medical science. He will be long known as the discoverer of *urea stibamine*, a specific for Kala-azar (Visceral Leishmaniasis), which reduced the mortality rate from 99 per cent. to 1 to 2 per cent., and which proved to be a great boon to the suffering humanity not only in India but also in the Near and the Far East.

Upendranath was born on 19th December 1873, in Jamalpur, Bihar. His father, Dr. Nilmoni Brahmachari, was a well-known medical practitioner of the place. Young Brahmachari had a brilliant school career and even in college he proved himself to be of very superior merit. He got his B.A. Degree with Honours in Mathematics from the Hooghly College and secured first class in his M.A. examination in Chemistry from the Presidency College, Calcutta. In spite of his preference for academic work, the wishes of his father prevailed upon him and he decided to go in for medical education. He joined the Calcutta Medical College and passed the L.M.S. (1898) and M.B. examinations (1899) with distinction.

After his medical education, he entered the Bengal Medical Service, joined the Dacca Medical School as a teacher and was posted at the Mitford Hospital. During the time he was there, he commanded a lucrative practice and made a name for himself as a physician of great promise. His love for academic work helped him to obtain the M.D. Degree (1902), and two years later, the Ph.D. Degree in Physiology, the subject of his thesis for the latter being "Studies on hæmolysis." It may be said here that practically no other medical graduate in India was equipped until recently, so well in the basic as well as in the medical sciences.

To further his future prospects and expand his field of activities, Brahmachari joined the Campbell Medical School, Calcutta, as a teacher of medicine. His most important work was carried out here during the period 1905 to 1923. He was selected as a research worker under the *Indian Research Fund Association*, in which capacity he continued his researches for nearly six years. He collected together a band of young organic chemists from the Calcutta University and started work on the chemotherapy of Kala-azar with antimony compounds. It is not known exactly how he got the idea of combining stibenylic acid with urea, but, perhaps, from the analogy of combining quinine with urea, he conceived the idea of producing urea stibamine—which brought him fortune as well as fame.

In 1923, he became the additional physician to the Calcutta Medical College Hospitals, being perhaps the first non-I.M.S. physician to be so honoured. After retirement, he became the Honorary Professor of Tropical Medicine at the Carmichael Medical College and Professor of Biochemistry at the Calcutta University where he continued as such until his death.

Brahmachari made valuable contributions as a clinician as well as a chemotherapeutist, though his contributions to Kala-azar eclipsed his other works. He was the first to describe cutaneous leishmaniasis which is still listed as dermal leishmaniasis (Brahmachari) in the various books on tropical medicine. He also made important contributions to the field of anti-malarial chemotherapy by his studies on quinoline and acridine compounds.

Brahmachari's work was of such a fundamental and far-reaching nature that he got recognition from all quarters, both cultural and scientific. He was elected President of the *International Association of Microbiologists*, a Fellow of the *Royal Society of Medicine*, London, and also a Fellow of the *Royal Society of Tropical Medicine and Hygiene*, London. He held the offices both of the Vice-President as well as of the President of the

(Continued on page 629)

NON-TECHNICAL NOTES

27.—DRAWN LAMINATED MOULDINGS

REALIZING the importance of the development of plastic industry in this country, the *Council* has undertaken a number of investigations in the field. Drawn laminated mouldings represent one of the developments which has reached a successful stage.

The technique for the manufacture of drawn laminated mouldings, as developed in the *Council's* laboratories, combines the various features of the following processes:—

- (1) Compression moulding from plastic moulding powders,
- (2) Manufacture of resin-impregnated laminated sheets and boards, and
- (3) Metal sheet drawing and pressing.

The technique of powder mouldings for the production of numerous types of deep, shallow and intricate articles is generally well known. By virtue of their intrinsic physical structure, such mouldings have the serious drawback of relative brittleness, and consequently, require a fairly heavy construction to give the desired strength to the final article.

Resin-impregnated laminated sheets and boards, however, possess an extraordinary degree of toughness due to the co-ordinated strength of the fabric used in their manufacture.

It was, therefore, felt that if full advantage was taken of the inherent properties of laminated materials, and intricate shapes produced by the use of impregnated sheet fabric instead of moulding powders, a considerable saving could be effected in material cost and the physical properties of the final product considerably improved.

Such a development necessitated, to some extent, the utilization of the technique used in metal sheet drawing and pressing, in which field it is well known how a flat metal sheet could be drawn and pressed into articles of intricate shapes.

After considerable development work in this field, it can now be claimed, that a successful technique for the production of drawn laminated mouldings has been developed. Patents are being applied for in India

as well as abroad for the protection of the process.

A number of mouldings in attractive shapes and designs have been produced to illustrate the possibilities of the technique. Examples include ash trays, cigarette cases and containers, shoe polish containers, dentifrice containers and electrical fixtures such as ceiling-roses. The possible range of articles which could be produced by the use of this technique extends over the whole field of plastic moulded articles characterized by a thin cross section of the walls as compared to other dimensions of the finished articles. Examples of such articles are: cups, saucers, electrical switches and plugs and containers of almost all shapes and sizes.

Process

The laminations used for the purpose may be obtained from jute hessian, jute canvas, jute *dosootie*, cotton canvas, longcloth, etc., impregnated with resin in the form of solution, dried and cured at suitable temperature for a given period of time. The impregnation may be carried out ordinarily by soaking, but for superior grade articles, impregnation under vacuum and pressure may be employed. The conditions of impregnation and drying and pretreatment, if any, before moulding will depend on the resin used for impregnation. Thus far, the process generally corresponds to the preliminary stages of the process for the production of laminated boards. The lamination blanks of predetermined shape and size, depending upon the shape and size of the moulding, are punched out of the resin-impregnated sheets and as many of them as are needed to give the desired wall thickness are pre-heated to obtain the necessary plasticity before being fed into the specially designed moulds and pressed to the final shape. The real secret of success lies in the design and construction of the moulds and their operation.

Raw Materials

As already indicated under "Process," the raw materials needed are woven fabric,

a suitable natural or synthetic resin of which several will be available and solvents. Exact conditions for the use of the natural resin, shellac, and of the synthetic resin, phenol formaldehyde, have been fully determined.

Equipment

The moulding factories in existence for which this development is admirably suited, possess most of the equipment needed for the successful exploitation of the process. But as the plastic industry is becoming more and more popular in this country, and a number of *entrepreneurs* might feel interested in the process, a general idea of the equipment required is given below.

The equipment can be divided under three main heads, and the suggestions made are for a moderate size factory.

1. *Manufacture and Maintenance of Moulds.*—This needs a well-equipped workshop with:

- (a) Lathes, 6' and 4',
- (b) drilling machines upto 1" capacity,
- (c) shaper of 12" stroke,
- (d) grinding machines,
- (e) pantograph, and
- (f) die makers' accessories.

2. *Impregnation.*—

- (a) Impregnating machine with feeding, drying and collecting arrangements (this could be substituted by simpler equipment for manual operation), and
- (b) vacuum and compression pump with impregnating vessels to suit. (This is only required in the case of high grade products.)

3. *Moulding.*—

- (a) Three punching presses with accessories,
- (b) twelve hydraulic presses of 50 to 100 ton capacity (steam or electrically heated),
- (c) boiler of medium size for 100 lbs. pressure (not required if press is electrically heated), and
- (d) hydraulic pump and accumulator.

With steam heating, the electrical power required would be about 20 kw.; otherwise the figure will be about 45 kw.

The above equipment and a total covered space of about 5,000 sq. ft. would require a capital investment of approximately Rs. 2,00,000.

Cost

Except for the fancy articles which may be expected to fetch high prices, the aim should

be to utilize the cheapest woven fabrics such as those from jute, in order to keep the cost as near as possible to the fillers used in ordinary moulding powders. In the case of cheap materials such as jute cloth, the mouldings can be easily expected to compare favourably with those from moulding powders in their cost of production, as the higher cost of the fabric compared to the cost of fillers in the moulding powder, will be compensated by the comparatively lighter weight of the laminated mouldings. If the waste cuttings from punching operations were utilized for the manufacture of ordinary moulding powders, further savings could be expected.

In cases where the mouldings are to be used as substitutes to metallic articles as a matter of necessity, the question of their being called upon to compete with their metallic counterparts need not arise. But even then the cost, as at present estimated, does offer a fair scope for competition. The instance of shoe polish containers is given here as an example.

The metallic containers of big Kiwi size from second-hand tin sheets are now selling at Rs. 9 per gross. Against this, the expected prime cost per gross for plastic containers would be Rs. 5-6 which leaves a fair margin for overhead charges and profit. Further saving could be expected in printing and labelling charges which will not be necessary in the case of these containers, as the necessary matter could be embossed during the process of pressing and the finished article produced in attractive colours.

Cost Sheet

Although a large variety of mouldings could be and would be produced by the process, yet for the sake of giving some idea of the economic implications of the process, cost sheets for the production of shoe polish containers and ash trays are given below. These are based on the use of phenol-aldehyde resins, the manufacture of which in the country should not offer any difficulty in these post-war days. This resin could also be readily purchased from manufacturers abroad if so desired.

Shoe Polish Containers.—Taking each cycle of operation at 4 minutes, shoe polish containers area as 7 sq. inches, and necessary pressure at 1.2 tons per square inch, we can expect from a 100-ton hydraulic press 12 cavity moulds 1,440 impressions per press per shift of eight hours. Two such presses

could then yield a total of 5,760 impressions yielding 2,880 (say 2,800) containers in two-shift working per day.

For handling this production, the various costs involved are (leaving the overhead and supervising staff out of consideration):

	Per day	
	Rs.	a.
Labour:		
Bearers, at Rs. 40; one supervisor, at Rs. 150; mistries, at Rs. 60; two boiler men, at Rs. 60 for resin preparation, impregnation of fabric, blanking, moulding and attendance to boiler	30	0
Fuel and power (being an estimate based on rates prevailing in Delhi for a consumption of 80 units of electric power per day and 8 maunds of coal at 1 anna per unit, and 6 annas per maund respectively)	16	0
Raw materials. 94 sq. yards of impregnated jute cloth at Rs. 19 per 24 sq. yards (approx.)	75	0
	Rs.	121 0
Less credits for 94/3 lbs. of moulding powder from waste after blanking at 1 lb. per sq. yd. and 8 annas per lb. for the moulding powder	15	11
Net cost	105	5
Cost per gross	5	6

This compares quite favourably with the present price of Rs. 9 to Rs. 10 per gross for metallic containers.

Ash Trays.—Taking each cycle of operation at 4 minutes, ash tray's projected area at 14 sq. inches and pressure at 1.2 tons per sq. inch, we can expect from a 100-ton hydraulic press using six cavity moulds, 720

impressions per press per shift of 8 hours. Stipulating again on the assumption that two such presses will be employed for two shifts we can expect 2,880 ash trays per day. In this case, cost of labour and fuel will remain the same as above.

	Rs.	a.
Labour per day	30	0
Fuel and power	16	0
Raw materials (120 sq. yards of impregnated jute cloth at 24 ash trays per sq. yard using two blanks per tray)	95	0
Total	141	0
Less credits for 40 lbs. of moulding powder at 8 annas per lb.	20	0
Net cost	121	0
Cost per ash tray	8.1	pies

Prime cost for a similar ash tray when moulded from a moulding powder (taking its weight in the case of powder at 40 gms., i.e., double that of laminates, which is required to achieve the necessary strength) costing 8 annas per lb. comes to 8 pies (approx.).

It will thus be seen that with cheap fabrics like jute cloth, the mouldings from laminates compare very favourably with those from powders, with the added advantages of greater strength and longer life.

Selling price of such ash trays varies a great deal, but may be taken to be from 4 to 8 annas each. Really attractive ash trays using coloured fabrics on the outside and jute on the inside could be produced with a little extra cost, which will secure much higher price.

28.—MANUFACTURE OF CARBON COMPOSITION RESISTANCES FOR RADIO PURPOSES

THE carbon composition resistances are greatly in demand for assembly and replacement purposes in radio receiving sets and in amplifiers and other radio and audio devices. The requirements are that they should give their correct values under all conditions and maintain the values for a sufficiently long period; they should give negligible or minimum "noise voltage" due to thermal agitation when connected in a valve circuit.

The total number of radio sets now in use in the country is approximately 250,000 and placing the demand for replacement at the rate of 5 resistances per set, the requirements of the country for this purpose come to 1,250,000. Besides this, the figures for radio set and amplifier assemblies, can be safely placed at 5,000 and 100,000 respectively, leading to an additional demand of about 5,000,000 resistances. This demand can further be expected to increase with the

establishment in India of radio factories in the near future.

Considering the possibility of increment in the number of radio sets by, say, 50,000 per year and assuming that at least a total of 50,000 sets per year will be produced in radio factories proposed to be established in India in the near future, we would require about 87,50,000 or more resistances per year after 5 years from now for replacement and assembly purposes.

Process

These resistors consist of carbon as the conducting material, a binding material and a filler. The three ingredients are thoroughly mixed and the mix is made plastic by the addition of a known quantity of an organic solvent. The plastic mass is then extruded through dies in an extrusion press, heat-treated and cut to the required size. Their ends are coated with a metallic spray, and terminal wires are soldered to the coating. The resistors are finally tested and coloured according to the standard colour code.

Raw Materials

Almost all the raw materials needed for the manufacture of resistances are easily available in the country.

Equipment

The following is the equipment needed for manual production:

- (1) Extrusion press and accessories,
- (2) metal spraying equipment and air compressor unit,
- (3) ball mill with accessories,
- (4) moulds and dies,
- (5) furnace for heat treatment,
- (6) testing and measuring equipment (including an arrangement for measuring "internal noise"), and
- (7) electric motors.

The exact sizes and capacities of the various items of equipment mentioned above will depend upon the production aimed at. The total estimate of price for the entire equipment to handle a production of six million resistances per year would be nearly Rs. 40,000 and that for 200,000 resistances nearly Rs. 20,000. Most of the equipment except some instruments is now being made in the country. Extrusion presses can be supplied by *Messrs. Simplex Manufacturing Co.*, Daryaganj, Delhi, the metal spray gun and compressor by *Messrs. Didwania Ltd.*,

Hamam Street, Fort, Bombay, and furnace by *Messrs. General Electric Co., Ltd.*, Calcutta and Bombay. As regards the rest, there should be no difficulty in obtaining them as most of the instruments are now being imported into the country by firms dealing with scientific instruments.

Cost Sheet

The cost will vary according as the commercial development of the process is undertaken on a limited scale as a sideline by any of the existing firms manufacturing radio components, or is undertaken as a self-contained industry by itself on a fairly large scale. Below are given the estimates of prime cost separately for different volumes of production, small and large, on the basis of an annual output of two hundred thousand and six million resistances respectively. It is evident that as labour accounts for a substantial proportion of the total cost, it would be preferable to adopt the automatic process, if production on the larger scale is contemplated (information regarding automatic machinery may be obtained from the U.S.A. companies like *Erie Resistor Co.*, *International Resistance Co.*, etc.).

I. For 200,000 Resistances of Assorted Sizes (Based on 10 per cent. rejection)

	Rs.
Raw materials	5,000
Labour (unskilled)	8,000
Technical supervision	4,800
Power	1,000
	Rs. 18,800

Approximate cost per resistance .. 1.5 annas

II. For 60,00,000 Resistances (Assorted) (Based on 10 per cent. rejection)

	Rs.
Raw materials	1,50,000
Labour (unskilled)	1,00,000
Technical labour and supervision ..	40,000
Power, etc.	10,000
Building rent	2,400
	Rs. 3,02,400

Approximate cost per resistor .. 0.8 anna

These prices compare quite favourably with the prices of imported resistors estimated at about two annas each for assorted sizes.

ATOMIC ENERGY

Atomic Energy. A General Account of the development of methods of using Atomic Energy for Military purposes under the auspices of the United States Government, 1944-45. By Prof. H. D. Smyth (Published in the United States of America by the Government Printing Office. Reprinted by H. M. Stationery Office, London), 1945, pages 144.

“THE story of the development of the atomic bomb by the combined efforts of many groups in the United States is a fascinating but highly technical account of an enormous enterprise. Obviously military security prevents this story from being told in full at this time. However, there is no reason why the administrative history of the Atomic Bomb project and the basic scientific knowledge on which the several developments were based should not be available to the general public,” says Major-General L. R. Groves, in his Foreword. All pertinent scientific information is given in the volume. Indeed, an ordinary citizen cannot be expected to understand how an atomic bomb is constructed, but he may be interested in knowing the general scientific facts which have been utilized in preparing the bomb. An attempt has been made in the following to give a consolidated account of the scientific developments which have led to the utilization of the atomic energy.

The atomic bomb, which has ushered in a new era in scientific warfare, is the result of the work of a large number of scientists during the last fifty years. The phenomenon of radioactivity was discovered in 1896 by Henry Becquerel, and the Curies isolated several radioactive substances. But it was mainly the investigations of Rutherford and his co-workers at Montreal, Manchester and Cambridge that proved that radiations given out by radioactive substances are of three types, that the atoms consist of a central nucleus which carries the whole mass of the atom and a positive charge equal to the atomic number of the atom, and that the central nucleus can be disintegrated by bombarding it with one of the radiations (α -particles) given by the radioactive sub-

stances. Bothe and Becker in 1930 observed that the disintegration of beryllium, by fast α -particles, emitted very penetrating radiations which were shown by Chadwick to be neutral particles of the same mass as the proton. It was shown by Fermi that neutrons, because of their lack of charge, must be very effective in producing nuclear changes, especially in the case of heavier atoms which repel strongly the charged particles on account of their high positive central charge. Fermi and his colleagues bombarded uranium by neutrons but the results of their experiments were puzzling and were not understood at that time.

Hahn and Strassmann in 1939 discovered that one of the products of the bombardment of uranium by neutrons was barium. Frisch and Meitner suggested that the absorption of the neutron by a uranium nucleus caused the nucleus to break into two approximately equal parts. In this process of “Uranium-fission” a large amount of energy is released due to the conversion into radiation of a small part of the nuclear mass, in accordance with the mass-energy-equivalence principle of Einstein (1905), experimentally verified in 1932 by Cockcroft and Walton. The energy released due to the fission of a uranium nucleus is of the order of 200 million electron-volts. It was pointed out by Bohr and Wheeler, on theoretical considerations, that whereas fast neutrons could effect the fission both of U-235 and U-238 (uranium consists of three isotopes of masses 238, 235 and 234, the last being present in very minute quantities) slow neutrons cause the fission of U-235 only. U-238 captures slow neutrons without fission and transforms into U-239 which by two successive β -ray emissions changes first into neptunium (Np-239) and finally into plutonium (Pu-239). It was found that the process of fission is accompanied by the emission of fast neutrons, the number of neutrons released per fission lying between one and three. These neutrons may cause the fission of other uranium nuclei and thus a chain reaction may be realized.

The need of a chain reaction can easily be understood from a consideration of our

orthodox methods of obtaining energy. "Combustion is always self-propagating; thus lighting a fire with a match releases enough heat to ignite the neighbouring fuel, which releases more heat which ignites more fuel, and so on." The fission of uranium furnishes us with such a nuclear reaction. The fission is brought about by neutrons. Each fission produces more than one neutron which can cause the fission of other uranium nuclei and so the process can be built up. But in addition to producing fission, the neutron may be lost in other ways also; thus the neutrons may entirely escape from uranium, they may be captured by uranium without causing fission or they may be captured by impurities. It is only when the number of neutrons lost by these processes is less than the surplus neutrons produced by fission that the chain reaction can be realized.

The relative number of neutrons escaping can be reduced by increasing the volume of the material. The greater the amount of uranium, the smaller the probability that the neutron will escape. But the ratio of non-fission neutron-capture, which is most probable for neutrons of intermediate energies, does not depend upon volume. Also the fission-capture is most probable for slow neutrons while the neutrons emitted in the fission process have high energies. Obviously, therefore, to increase the probability of fission-capture, the emitted neutrons must be slowed down by such judicious distribution of slowing down materials that fission-neutrons encounter a uranium nucleus only after their energy has been sufficiently reduced. Light elements are known to be the best slowing down agents or "moderators" for neutrons.

The chain reaction can, therefore, be sustained by (1) separating from ordinary uranium, U-235 which has a large probability for fission or (2) by suitable use of moderators with ordinary uranium. One advantage of the latter method is that as the reaction proceeds some of the U-238 is changed into Pu-239, which like U-235 has a large fission probability. A definite manner of using the moderator was first suggested by Fermi and Szilard. "The idea was to use lumps of uranium of considerable size imbedded in a matrix of moderator material. Such a lattice can be shown to have real advantages over a homogeneous mixture."

Also the plutonium produced being chemically distinct from uranium, can be easily separated while for the separation of the isotopes we have to rely on processes depending on the nuclear mass. Although large-scale separation of isotopes was not actually used for the manufacture of the atom bomb, it is useful to review briefly the methods used and the results achieved.

"The principal factors that may have to be considered in devising a separation process are: equality of average thermal energy of molecules at a given temperature, gravitational or centrifugal effect proportional to the molecular masses, electric or magnetic forces affecting ionized molecules, and interatomic or intermolecular forces."

Of the several methods available in principle, only those of gaseous diffusion, thermal diffusion and electromagnetic separation have been used in the case of uranium isotopes. "As long ago as 1896, Lord Rayleigh showed that a mixture of two gases of different atomic weights could be partly separated by allowing some of it to diffuse through a porous barrier into an evacuated space. Because of their higher average speed, the molecules of the light gas diffuse through the barrier faster, so that the gas which has passed through the barrier is enriched in the lighter constituent and the residual gas is impoverished in the lighter constituent." The ideal separation factor α is given by

$$\alpha = \sqrt{\frac{M_2}{M_1}}$$

where M_2 and M_1 are the molecular weights of the heavier and lighter gases respectively. In the case of uranium, the compound used is uranium hexafluoride. For this the value of α is only 1.0043. It is, therefore, necessary to use a multiple-stage recycling system for large-scale separation of the uranium isotopes. "The best flow arrangement for the successive stages is that in which half the gas pumped into each stage diffuses through the barrier, the other (impoverished) half being returned to the feed of the next lower stage." The material that finally emerges has been recycled many times and it was estimated that "it may be necessary to force through the barriers of the first stage 100,000 times the volume of gas that comes out at the top of the cascade." The main problems were the development of satisfactory barriers, pumps and seals. Many acres of barrier surface is necessary. Also "the barrier

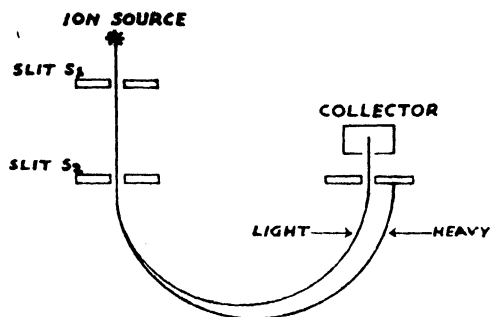
material must have no holes which are appreciably larger than 0.01μ but must have billions of holes of this size or smaller. These holes must not enlarge or plug up as the result of direct corrosion or dust coming from corrosion elsewhere in the system. The barrier must be able to withstand a pressure head of one atmosphere. It must be amenable to manufacture in large quantities and with uniform quality." Before the summer of 1945, uranium was successfully being separated by this method.

The possibility of using thermal diffusion for isotope-separation was first suggested by Enskog and Chapman. If a temperature gradient is maintained in a gaseous mixture, there is a tendency for one type of gas to accumulate in the cold region and of the other in the hot region. "Such thermal diffusion effects were first used to separate isotopes by Clusius and Dickel in Germany in 1938. They built a vertical tube containing a heated wire stretched along the axis of the tube and producing a temperature difference of about 600°C . between the axis and the periphery. The effect was twofold. In the first place, the heavy isotopes (in the substances they studied) became concentrated near the cool outer wall, and in the second place, the cool gas on the outside tended to sink while the hot gas at the axis tended to rise. Thus thermal convection set up a counter current flow, and thermal diffusion caused the preferential flow of the heavy molecules outward across the interface between the two currents."

The theory of thermal diffusion is very intricate and the effect depends not only on the difference between the masses of the two gases, but also upon their effective molecular diameters. In the case of uranium, a liquid compound of uranium was used for a partial separation of the two isotopes, the product being used as feed material for the gaseous diffusion plant and the electromagnetic separator.

The principle of the mass-spectrograph electromagnetic separator depends upon the fact that ionized atoms or molecules of different masses, when accelerated by the same potential, possess different momenta and are, therefore, bent in different paths by a uniform magnetic field, the path of the particle of smaller mass having a smaller radius of curvature. The gaseous compound to be separated is introduced into the ion source where it is ionized by an electric

discharge. Some of the ions pass through the slit S_1 and are accelerated by an electric field between S_1 and S_2 . They are then bent by a magnetic field perpendicular to the plane of the paper and thus separated and collected in a collector placed along a diameter where the beams are again focussed.



The method effects almost complete separation but was not considered originally because it could handle only small quantities of the material. This is due to three factors. "First, it is difficult to produce large quantities of gaseous ions. Second, a sharply limited ion beam is usually employed so that only a fraction of the ions produced are used. Third, too great densities of ions in a beam can cause space-charge effects which interfere with the separating action." It was, however, found that the space charge could be neutralized by the ionization of the residual gas in the magnet chamber. The method of producing large quantities of gaseous ions has not been made public for security reasons, and a large fraction of the ions produced has been used by widening the slits S_1 and S_2 . The width of the slits has to be limited so that the image of S_2 at the collector end will be smaller than the separation between the heavy and light molecules. To increase the width of the slits, therefore, the separation between the heavy and light particles is increased by using giant cyclotron magnets of pole diameter 184". The plant employed was called the "Calutron" (California University Cyclotron).

As has already been remarked, the feed material for the electromagnetic separator was partly enriched by the thermal diffusion method. Even then it was not aimed to effect complete separation in one stage as then the yield would be impracticably small. Several stages were, therefore, used,

each stage effecting only a partial separation. It was also found possible to maintain more than one ion beam in the same magnetic separating region. Another advantage with the electromagnetic separator was that each unit was practically independent of the others, so that improvements in the design of subsequent plants could be effected on the basis of the experience gained in the working of the previous ones. This method was the first to produce large amounts of the separated isotopes of uranium. "The electromagnetic separation plant was in large-scale operation during the winter of 1944-45, and produced U-235 of sufficient purity for use in atomic bombs."

Another electromagnetic method which was studied, but not used for large-scale separation of the isotopes, was intentionally given the meaningless name "isotron." Ions from an extended source are first accelerated by a strong electric field. All particles acquire the same energy and hence their velocities are inversely proportional to the square root of their masses. They are now subjected to a low intensity electric field varying in radio frequency. This field introduces a periodic variation in the velocity of the ions causing them to "bunch" at certain distances down the tube. The bunches of ions of different mass travel with different velocities and are thus separated. They are now subjected to a focussing field superposed upon which is a transverse field with a periodic variation. This transverse field is a maximum when U-238 ions reach it, and zero when U-235 ions reach it. U-238 ions are thus deflected sideways and the ions are collected in different collectors.

It is not U-235 which has been actually used for the manufacture of the atomic bomb but Pu-239, which is obtained from U-238 by the action of neutrons. For this purpose a pile of uranium blocks imbedded in a matrix of moderators is constructed. For the successful operation of such a pile, it is necessary to be able to control it. This is effected by inserting in the pile at suitable places tubes of materials such as cadmium which act as neutron absorbers. By drawing these tubes in or out of the pile the reaction can be controlled. As moderator material, one of the lighter elements was chosen and various considerations led finally to the choice of graphite.

"Since the object of the chain reaction is to generate plutonium, we would like to

absorb all excess neutrons in U-238 leaving just enough neutrons to produce fission and thus to maintain the chain reaction. Actually the tendency of the neutrons to be absorbed by the dominant isotope U-238 is so great compared to their tendency to produce fission in the 140-times rarer U-235 that the principal design effort had to be directed towards favouring the fission (as by using a moderator, a suitable lattice, materials of high purity, etc.) in order to maintain the chain reaction." The object of the moderator material is to obtain from fast fission-neutrons thermal neutrons which have a very large probability of producing fission in U-235. It is, therefore, necessary to keep the pile at room temperatures and a coolant must be used to absorb the large amount of heat produced in fission. Water was used for this purpose and was circulated in the pile through pipes which must be made of a material which has a small absorption coefficient for neutrons. Further, it should "not disintegrate under the heavy density of neutron and gamma radiation present in the pile. Finally, the pipes must meet all ordinary requirements of cooling systems. They must not leak; they must not corrode; they must not warp." Aluminium was finally chosen and proved to be excellent.

All the piles depend on stray neutrons from spontaneous fission or cosmic rays to initiate the reaction. In order that the action may then build up, the multiplication factor K must be greater than unity. Suppose there are N high energy fission neutrons at the start. Some of these suffer loss of energy due to collisions with the moderator, etc., the energy being reduced to thermal energy (taken to be 0.025 electron-volt). Some of the fast neutrons, however, produce fission and we can take this into account by multiplying the original number N by a factor ϵ . While the neutrons are being reduced to thermal energies, a certain fraction is lost by resonance capture by U-238. This can be expressed by multiplying $N\epsilon$ by a factor p where p is the resonance escape probability and is less than one. The thermal neutron may now be absorbed by the moderator, the coolant and other materials present. A certain fraction f will be available for absorption by uranium. If η represents the number of neutrons produced for each thermal neutron absorbed in uranium, the final number of neutrons produced is $N\epsilon pf\eta = NK_{\infty}$ where

K_{∞} is the multiplication factor for a pile of infinite radius. In order that the chain reaction may be sustained, the multiplication factor must be greater than unity.

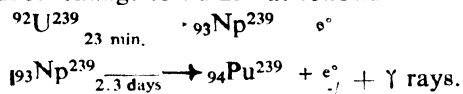
The first pile, built on these principles, was operated successfully on 2nd December 1942. It was designed to be built in the form of a sphere with uranium or uranium oxide blocks spaced in a cubic lattice imbedded in graphite. Control measurements showed that the critical size had been reached before the sphere was complete and the final structure, therefore, was in the form of an oblate spheroid flattened at the top. The multiplication factor K was observed to be about 1.0006 when all neutron absorbers (used as controls) were removed. The number of neutrons emitted by the pile per second was estimated in terms of the activity of standardized indium foils. The experiment was performed under the general direction of Fermi assisted by others. Initially, the pile was operated at a power level of $\frac{1}{2}$ watt, but later the power level was raised to 200 watts.

Although the cubic lattice was theoretically the ideal one, there are two practical objections against it. "First, it is difficult to remove the uranium without disassembling the pile; second, it is difficult to concentrate the coolant at the uranium lumps, which are the points of maximum production of heat." A rod lattice, therefore, was actually used, and uranium rods could be pushed out of the cylindrical channels in the graphite moderator and new uranium inserted. The final piles were operating at a power level of about 2,000 kw.

The choice of graphite as the moderator was due to its availability. Theoretically, a pile with heavy water as moderator would actually have been better. It takes, however, a long time to produce large quantities of heavy water. An experimental heavy water pile was nevertheless built and tested in May, 1944. It was comparatively small in size. "With uranium slugs in place, it was found that the chain reaction in the pile became self-sustaining when only three-fifths of the heavy water had been added. The reactivity of the pile was so far above expectations that it would have been beyond the capacity of the control rods to handle if the remainder of the heavy water had been added. To meet this unusual and pleasant situation some of the uranium was removed and extra control rods were added."

"In general the characteristics of this pile differed slightly from those of comparable graphite piles. This pile takes several hours to reach equilibrium. It shows small (less than 1 per cent.) but sudden fluctuations in power level, probably caused by bubbles in the water. It cannot be shut down as completely or as rapidly as the graphite pile because of the tendency of delayed gamma rays to produce (from heavy water) additional neutrons."

After the rods have been treated in the pile, the plutonium produced is separated from the fission products and the uranium left unchanged. After the pile is shut down, U-239 and Np-239 which are intermediate products change to Pu-239 as follows



"Four types of method for chemical separation were examined: volatility, absorption, solvent extraction, and precipitation. The work on absorption and solvent extraction methods has been extensive and such methods may be increasingly used in the main process or in waste recovery." But the actual method adopted consisted of a series of reactions including precipitation with carriers, solution, oxidation and reduction. This method is commonly used in radio chemistry. Details of these processes as well as those of extracting metallic uranium or uranium oxide from the ore or of preparation of pure graphite to be used as moderator, have not been made public. The operation of the pile and the separation of plutonium were carried by remote control and behind thick shields in order to protect the personnel from the harmful effects of strong reactions of neutrons and gamma rays. At the same time workers were constantly examined to determine the extent of exposure.

The actual production of the atomic bomb was carried out at Los Alamos in New Mexico under the general direction of J. R. Oppenheimer. In operating the pile, controlling rods are inserted so that the pile may not blow up. In the atomic bomb the main object is to make it blow up.

To have an effective explosion, it is necessary that the chain reaction builds up very rapidly so that a large part of the bomb material is utilized for the production of energy before the bomb flies apart and the reaction stops. Also the material must be safe to handle. The second requirement is

automatically satisfied by the fortunate fact that the bomb material does not explode if it is below a certain critical size. To produce the detonation then the parts of the bomb must be brought together rapidly. Once the reaction has started it proceeds rapidly but the bomb may expand very rapidly to such an extent that the reaction stops before a large part of the bomb material has undergone fission. Hence the bomb must be surrounded by substances of the highest density which on account of their inertia will retard the expansion. It so happens that these substances of high density turn out to be good reflectors of neutrons and thus prevent the escape of neutrons to the outside.

The actual assembly of the bomb presents considerable difficulty. The method used has not been revealed, but one method suggested was to shoot one part of the bomb as a projectile in a gun against a second part as a target. The size of the bomb too has not been revealed but it is surmised that it was about 150 lbs. in weight. The colossal nature of the undertaking which led to the atomic bomb will be appreciated when it is pointed out that about 3,500 top ranking scientists—physicists, chemists and chemical engineers—were engaged in research, development and operation in the Manhattan Project. 12,000 college graduates were on the job; 125,000 people (including the construction crews) were employed at the peak and a total of about 400,000 persons had worked at one time or another on this huge secret.

This is a brief outline of the story revealed in the 144 pages of this volume. The story does not run even, and indeed there are a good many details the student would wish to know, but which have not been given for security reasons. Even with this limitation, the reader will find this official account of an epoch-making achievement both informative and educative. R. N. R.

India—Part I—Physical Basis of Geography of India. By H. L. CHHIBBER (Nand Kishore & Bros., Benares), 1945. Pp. 282, Pls. 10 & Figs. 19. Price Rs. 5.

In this book the author has attempted to combine the physical geography and geology of India. He has been able to produce a very useful book for the students and teachers of these subjects. The book is divided into 20 chapters. The first nine chapters are devoted to the descriptions of the physical features of India—mountains,

plateaux, rivers, lakes, glaciers, earthquakes, coastline and volcanoes. In the case of certain mountains only, the author has named the rocks of which those mountains are formed. He mentions the Western Ghats as formed of Deccan Trap. This is true of the northern half of the Ghats only, as the southern half is made up of Archean formations—gneisses and charnockites. A mention of the total extent of the Deccan Trap flows in India at this place seems to be unnecessary. In case of plateaux, their geology, minerals and forests are described in greater details than in the case of mountains. The relation between the "Plateau of the Deccan" (comprising the whole of the Peninsular India) and the "Deccan Trap Plateau" (comprising Central and Western India) may be brought out more clearly. The chapter on rivers contains a good account of the main Indian rivers and their tributaries and is illustrated with some photographs. A reference to the salt lakes of Rajputana as a potential source of sodium sulphate obtained as a by-product may be made in the second edition. The figures of production of soda from the lakes of Khairpur State are too old and not of much use, as since Dr. Cotter's visit in 1917, many of the productive lakes of this area seem to have become non-productive. Lonar Lake, Chilka Lake and Pulicat Lake should be described under separate headings. As put in the present form, they would appear at first sight to a beginner to be lakes of the Salt Range. The causes of earthquakes are too summarily dealt with to require a separate heading. In the chapter on volcanoes, the author has devoted most of the pages to the ancient volcanic activity in different geological periods. This description should have more appropriately gone to Chapter XVI on "Making of India."

In Chapter X, the author has given a good summary of the hot springs and mineral waters of India, but an alphabetical or some other order ought to have been followed in arranging the Provinces. Chapters XI and XII give the climate and the climatic regions of India. Chapter XIII is devoted to weathering and denudation, but the inclusion of the formation of river deltas and bars hardly fits in with the heading of this chapter.

An account of the geological formations of India has been given in the 21 pages of Chapters XIV and XV. The author has followed the old classification of Archean

System into Archeans and Dharwars, though as a result of recent surveys, it is becoming doubtful whether rocks older than Dharwars actually exist in any portion of Peninsular India. The account of the geological formations is naturally very brief and has led to certain omissions, e.g., not giving the age of the Upper and Lower Gondwanas on the international scale, and not including the names of the Barakar and Raniganj stages—the two important coal-bearing horizons of India. The style and type of headings had also led to certain ambiguities, e.g. (1) putting the area of distribution, "Peninsular India," and the geological formation, "Lameta Limestones," as two consecutive subheadings on page 182 under the description of Cretaceous formations of India; (2) Subathu series being printed in bold type as a heading on p. 186 and the overlying series, Dagshai and Kasauli, being given in italics inside the text.

Chapter XVI describes the geological history or "The Making of India." The omission of the formation of Salt Range in this chapter is regretted. The description of the economic uses of limestones and sandstones of the Vindhyan System and the paragraph on the economic importance of the plains are misfits in this chapter. The next two chapters, XVII and XVIII, describe the soils and soil erosion respectively. Chapter XIX deals with the fertilizers and manures found in India, and Chapter XX with the "Structure of India." In the opinion of the reviewer, the last chapter is rather out of place and is isolated. Its contents might have been appropriately combined with those of Chapter XVI on "Making of India."

Being primarily a geologist, the author has introduced (perhaps unconsciously) at many places geological names of formations, ages, rocks, structures, etc., in the beginning of the book, much before the chapters on "Weathering" and "Geology." This requires that the students should have some preliminary knowledge of the fundamentals of physical geology before they are asked to read this book as a text book.

In the preface, the author states that agricultural, forest and animal products comprise the raw materials upon which the development of industries depend. Minerals are equally important raw materials for the industries. Though the author has mentioned several economic minerals and rocks at different places in the book, and has des-

cribed the mineral waters in one chapter, and mineral fertilizers in another; he would have been quite justified to devote a separate chapter to the economic minerals of India or to include these minerals in greater details in the two chapters on "Geology," under individual geological formations of India.

The reviewer has put forward these suggestions for the consideration of the author, and for adoption in the second edition. These do not in any way belittle the value of the book, in the production of which the author has taken great pain. Dr. Chhibber deserves the thanks of all for this valuable addition to the few books on Indian Geography and Indian Geology. The get-up of the book is quite good in spite of the war-time difficulties. The book is strongly recommended to those for whom it is written.

N. I. S.

The Indian Pharmacist. Edited by PROF. M. L. SCHROFF (85-1, Upper Chitpore Road, Calcutta.) Annual Subscription Rs. 3. Single copy Re. 1.

The Indian Pharmacist, a quarterly journal devoted to the interests of the pharmaceutical profession, is a welcome addition to the list of professional journals in India. It is edited by Prof. M. L. Schroff, well known to the profession as Raja Moti Chand Professor of Pharmaceutics, Benares Hindu University, Founder-Secretary of the Indian Pharmaceutical Association and Editor-in-Chief of the *Indian Journal of Pharmacy*. Prof. Schroff organized the Indian Pharmaceutical Association in 1932, when the Drug Enquiry Committee of the Government of India published its Report. It is appropriate that he has started this journal when the Government Bill in the Central Legislature, which relates to the registration of pharmacists and the regulation of education and training of pharmaceutical chemists, is expected to be passed into law.

There is an increasing appreciation of the importance of pharmacy in matters relating to public health. The pharmaceutical services depend on the pharmaceutical industry, trade and education, and all these are receiving increasing attention in this country. A journal devoted to the efficient organization of pharmaceutical services has indeed become a necessity. Prof. Schroff combines both ability and experience for the task he has undertaken. We wish the new journal every success.

HEALTH SURVEY AND DEVELOPMENT

BHORE COMMITTEE'S RECOMMENDATIONS

“NO individual should fail to secure adequate medical care because of inability to pay for it.” This, says the report of the Health Survey and Development Committee, is one of the main principles underlying the Committee's proposals for future health and development in the country. The Committee was presided over by Sir Joseph Bhore and consisted of 24 members (8 officials and 16 non-officials).

The Committee has drawn up its health plan in two parts, one a comprehensive programme for the somewhat distant future and the other a short-term scheme covering a ten-year period. “We have taken the countryside as the focal point of our main recommendations, for the debt which India owes to the toiler of the soil is immense. When pestilence and famine sweep through the land, it is he who pays the heaviest toll and yet receives only the scantiest medical assistance. Further, nearly 90 per cent. of the people in India live in the rural areas and the basic problem before the country is the provision of adequate health protection to the preponderantly larger section of the community. We have, therefore, made the villager the chief beneficiary under the proposals.”

On the administrative side the Committee proposes: Ministries of Health at the Centre and in the Provinces, and Health Administrations in local areas. The Committee feels that the wide measure of autonomy that has been granted to the Provinces should be respected to the utmost possible extent. “In order to minimize friction and to promote mutual consultations between the Centre and the Provinces in the formulation of health policies and its implementation there should be established a Central Statutory Board of Health, consisting of the Central and Provincial Ministers of Health. The Centre, with its larger resources in money and technical personnel, should help the Provinces with grants-in-aid for the development of the health programme and with such technical assistance as may be required.”

Councils of Experts

The Committee considers that the Ministries of Health, Central and Provincial, should have the advice and guidance of technical experts in the planning and maintenance of the health services and, therefore, recommends the creation of Standing Councils of Experts at the three levels of Central, Provincial and local area administrations. These Councils will consist of representatives of the medical, dental, nursing and other professions.

The Committee has also recommended the establishment in Provinces of Provincial Health Boards and of Provincial Health Councils with composition and functions similar to those of the Central Board and Central Councils.

“The Ministry of Health, Central or Provincial,” says the Committee, “should be the ultimate authority responsible for all health services operating within its jurisdiction and should have power to lay down and enforce minimum standards of health administration for those services which are within the immediate control of other departments.”

The Committee points out that, as in the U.S.A., where the Federal Health Service has control of sanitation and inter-State traffic including supervision of sanitary facilities of all inter-State vehicles, the Central Government should be responsible for the enforcement of all measures necessary to prevent inter-Provincial spread of infectious diseases. Enforcement of standards regarding food and drugs in the inter-Provincial commerce should also be the function of the Central Government. In certain exceptional circumstances the Central Government should have power to take direct action in a Province in the interests of the country as a whole, but normally action should only be taken after consultation with the proposed Central Board of Health.

Recruitment to Services

It is proposed that the principal technical adviser to the Minister of Health should be the Director General of Health Services at the Centre and the Director of Health Services in a Province, who should function in each case as the single administrative officer for the curative and preventive departments of health. The Committee considers that there should be separate Central and Provincial Health Services. These services should normally be recruited in India but for a few posts in teaching and research institutions it may be necessary to recruit suitable persons from abroad on short-term contracts. One-third of the posts in the general health services should be filled on merit; in filling the remainder, consideration may be given to representation of the different communities.

Health Administration in Local Areas

The Committee envisages a comprehensive health service with recruitment, staff and conditions of service on similar lines throughout the Province and continuous and effective supervision by the higher technical staff over the work of the health personnel even in remote villages. Certain large municipalities such as Calcutta, Bombay, Madras and Karachi which are governed by their own Acts as well as other municipalities having populations of at least 200,000 which may be considered as being in a position to maintain an independent health service, may be excluded from the jurisdiction of the District Health Board. All these large municipalities should develop and maintain health organizations on the lines suggested by the Committee.

Long-term Programme

It has been considered advantageous that, as far as possible, the administrative district should be chosen as the area for the development of the scheme. An arbitrary figure of 3 million as the population for a district has been chosen and this is referred to as the 3-million plan.

The District Health organization will have a small unit of administration, the primary unit, which will normally serve an area with a population of about 10,000 to 20,000. A number of such primary units (15 to 25) will together form the secondary unit, a varying number of the latter (about 3 to 5) will form the District Health Unit, the designation by which the District Health organization will be

known. At each of the headquarters of the district, secondary and primary units will be established a Health Centre as the focal point from which the different types of health activity will be carried out into the territory covered by each unit.

The health organization is based mainly on a system of hospitals and health centres of varying sizes of different technical efficiency. These institutions will play the dual part of providing medical relief and of taking an active part in the preventive campaign. Work in connection with maternity and child welfare, tuberculosis, leprosy, etc., will be carried into the homes of the people from the health centres, at which social workers are to be employed in an honorary capacity.

Social Medicine

The Committee emphasizes that the treatment of disease has been approached not merely from the standpoint of offering the patient immediate relief but also from the point of view of social medicine, by attempting to remove the causes which are responsible for his or her condition. Suitable housing, sanitary surroundings and safe drinking water supply are prerequisites of a healthy life, states the Committee, which points out that the improvement of nutritional standards, qualitatively and quantitatively, elimination of unemployment and provision of a living wage for all workers and improvement in agricultural and industrial production and in means of communication, particularly in the rural areas, are all facets of a single problem and call for urgent attention.

"Nor can man live by bread alone. A vigorous and healthy community life in its many aspects must be suitably catered for. Recreation, mental and physical, plays a large part in building up conditions favourable to sound individual and community life and must receive serious consideration. Further, no lasting improvement of the public health can be achieved without arousing living interest and enlisting the practical co-operation of the people themselves.

"The idea must be inculcated that, ultimately, the health of the individual is his own responsibility and the most effective means seems to be to stimulate health consciousness by providing health education on the widest possible basis as well as opportunities for his active participation in the local health programme."

Short-term Programme

Under the short-term programme, while the outlines of the general plan of the District Health organization will follow those indicated for the long-term programme, the plan will be less elaborate. It is suggested that in view of the insufficiency of funds and of trained personnel, each primary unit should cater, during the first ten years, for a population of 40,000 (as against 10,000 to 20,000 under the long-term programme) and that the establishment of the District Health Centre be postponed till after the tenth year. The staffing and equipment of the health centres at the headquarters of the primary and secondary units will be on a reduced scale. It is proposed that the new organization should be extended to cover half the population of each district at the end of the tenth year. There will be one hospital for every 1,000 population at the end of ten years.

Ministries of Housing and Town and Rural Planning

The Committee recommends that there should be in each Province a Ministry of Housing and Town and Rural Planning, with wide powers to deal with

the housing of the industrial population and with the zoning and location of industries. Before the establishment of any new industry or factory is agreed to, the Provincial Minister should satisfy himself that in the layout adequate provision is made for the housing of workers (on certain scales laid down), for their transport to and from the factory and for adequate environmental amenities.

New industries should be dispersed in rural areas so that local inhabitants may derive the fullest benefit from industries being brought within their immediate circle while the health problem of workers in such industries will be greatly simplified. The present system of establishing factories near or in big towns, where the workers are forced to live in crowded tenements and under artificial and insanitary conditions, is harmful alike to town-dwellers and workers.

Improvement trusts should be established in a larger cities of the country for dealing with slum clearance, and re-housing problems. Every Trust should be required to employ a town-planner on its staff. The Committee does not suggest the creation of a Ministry at the Centre because direct responsibility for planning and execution will rest with Provincial Governments, but states that there should be at the Centre an Expert in Town Planning who, for the purpose of administration, may be attached to the establishment of the Director General of Health Services under the Ministry of Health.

Provincial Governments should consider the establishment of a statutory body, under the direction and control of the Ministry of Housing, of town and village planning with financial resources and power to plan and execute Province-wide house construction and town and village development programme on a 20-30-year plan, in five yearly stages. The Provincial Ministry of Health is vitally concerned in the proper execution of any housing scheme and should be responsible for the control and enforcement of minimum standards in the design and construction, not only of houses, but of environmental amenities, such as water supply, sanitation and recreation.

India-wide Housing Programme

An India-wide housing programme should give first priority to the needs of the lower income groups of the population. Governments should be prepared, both in rural and urban areas, to finance or assist in financing any approved schemes for new housing or housing improvement, whether sponsored by the Government themselves, by local authorities, by co-operative societies or by private interest. Governments must, however, exercise control over the planning and execution of such schemes and, in particular, over the rents to be charged for new houses and any increase in the existing rents in the case of housing improvement. Type designs for new houses, and suggestions for the improvement of existing ones should be available to villagers through the Health and any other Departments.

Water-supply

Only 253 out of 1,471 towns possess protected water-supplies.

A vigorous policy should be adopted for the development of a water-supply programme which should aim at providing the entire population with safe water for drinking and domestic purposes within 35 years. The establishment of Central and Provincial Water and Drainage Boards is recom-

mended. A programme for the provision of sewerage in all towns with a population of 50,000 and over in ten years is recommended.

Professional Education

The Committee suggests an output of 4,000 to 4,500 doctors a year as the target to be aimed at in the first ten years or roughly double the present output. They recommend that there should be one standard of medical training, that of the medical graduate, and that the training of licentiates should be discontinued within ten years. A reorganization of the medical curriculum and the establishment in every medical college of a Department of Preventive and Social Medicine are proposed. Economic barriers should not prevent suitable students from entering the medical profession and students willing to enter the public services after graduation should be given a stipend of Rs. 1,000 a year.

All-India Medical Institute

Side by side with the rapid production of as large numbers as possible of all categories of health personnel the Committee considers it essential to establish an All-India Medical Institute in order to bring together, in one place, educational facilities of the highest order for the training of doctors and of the more important types of health workers. The Institute will also train selected candidates from the Provinces for helping to man with suitable staff, the new medical colleges which will be established.

Organized Medical Research

At the present time research work depends mainly on two organizations: (1) the Central and Provincial Government laboratories and the Medical Research Department and (2) the Indian Research Fund Association.

The Committee recommends the constitution of a Central Medical Research Organization consisting of (1) a Scientific Board which will be the executive machinery of the organization and (2) an administrative body which would form the link between the Board and the Government of India and exercise general supervision over the working of the organization. The composition of the Scientific Board should include medical research workers of standing, experience, representatives of universities and medical colleges, representatives of the principal scientific bodies in India, prominent workers in the field of public health and medicine, non-medical representatives of allied and fundamental sciences and persons with experience of health administration. The Board would make recommendations regarding the allocation of funds for the furtherance of research to the Administrative Body, in which would be vested the power of giving sanction to such allocations.

Malaria

Malaria is by far the most important disease in India. An expansion of the Malaria Institute of India and the establishment of provincial malaria organizations and malaria control units is recommended.

Indigenous Systems of Medicine

The Committee suggests that it should be left to the Provincial Governments to decide what part, if any, should be played by the indigenous systems in the organization of public health and

medical relief. They point out that public health or preventive medicine is not within the purview of the indigenous systems which also do not deal with such aspects of medicine as obstetrics, gynaecology, and advanced surgery. The scientific systems of medicine they consider must be regarded as neither Eastern nor Western but as a corpus of scientific knowledge and practice belonging to the whole world.

Drugs and Medical Requisites

The Committee has stated that the final responsibility should rest with the Governments in India for seeing that the country's essential needs for drugs and medical requisites are met in such a manner as to make them available in adequate amount and of the proper quality to all sections of the people. In regard to all such articles as are of an essential nature the country should be made self-sufficient as far as possible.

Statistics to be Improved

The Committee points out that vital statistics are at present inaccurate and incomplete and recommends that steps should be taken to improve them. The appointment of a Registrar General of Vital Statistics and Population at the Centre and Registrars in the Provinces is recommended.

The Population Problem

The growth of population will, in the opinion of the Committee, become an increasingly serious problem. The prospects of emigration helping to lessen the pressure of population are remote and uncontrolled growth of population will eventually outstrip the productive capacity of the country. The Committee considers that the only practical steps that can be taken are, firstly, measures to raise the standard of living, and secondly, the spreading of the knowledge of birth control as far as the limitations imposed by the peculiar circumstances of the country will permit. All the members of the Committee are agreed that, when child-bearing is likely to result in injury to mother or infant, there is every justification for the practice of contraception and that Government agencies should give instruction in birth control methods in such cases. Some members consider that the State should provide such facilities to persons desirous of family planning for economic reasons also, while others hold that State action will be justified only if there is substantial support from public opinion.

Financial Problems

The Committee points out that at present Provincial Government expenditure on curative and preventive health measures constitutes a very small fraction of the total provincial expenditure, varying from 2.5 to 7.3 per cent., and they suggest that this percentage should be raised considerably. The present provincial expenditure ranges from 3.2 to 10.9 annas per head. The Committee estimates that their proposals will involve additional expenditure of Re. 1.3 per head in the first year and Rs. 2.13 in the last year of the ten-year programme.

The Committee suggests a searching inquiry into building costs and the data on which Public Works Departments base their estimates and states that there is a widespread and persistent belief that the Public Works Departments are unduly expensive agencies for the construction of public buildings.

NOTES AND NEWS

Heat Transmission Through Textile Fabrics

PEIRCE and Rees (*Shirley Institute Memoirs*, 1944-45, 19, 341) discuss theoretically the comfort which a clothed body derives from the fabric it wears in terms of the body temperature, the temperature of the atmosphere in which the body is placed and the nature of the fabric. For a normal skin temperature of a subject clothed in a given fabric, a temperature of the atmosphere called the comfort temperature is defined as that at which there is a normal rate of heat loss from the surface of the body. Assuming that "comfort is determined by a certain rate of heat loss through the clothing per unit area of the body, equal to H_c , and a certain skin temperature θ_s , then the comfort temperature θ_c is given by

$$6c \theta_s - H_c R$$

where R is the overall thermal resistance" and is a complex function of the thickness of the fabric and the radius of curvature of the surface of the body it clothes. New terms, specific thermal resistivity, equivalent air thickness, thermally effective specific volume and thermal insulating value, are defined and a new unit of thermal resistance, viz., the *tog* or the thermal resistance which maintains a temperature difference of 0.1°C . with a heat flux of one watt per square metre, is introduced.

An apparatus described earlier by Rees (*Shirley Institute Memoirs*, 1941, 18, 51) is modified to enable measurements of thermal transmission to be made in thick fabrics and fleeces and is described in this *Memoir*. The principal modifications are a larger experimental test surface—this time a square copper plate $6" \times 6"$ surrounded by a guard ring of copper $2"$ wide—the provision of an electrical heating grid for both the plate and the guard ring with suitable mica insulations and the use of copper constantan thermo-couples for measuring temperatures. The result of measurements shows that the relation between thermal resistance and thickness of fabric is a linear one, thermal resistance increasing with increasing thickness of fabric. Under Didsbury conditions, the thermal resistance of light summer clothing of 4.01 mm. comes out to be one *tog*.

On the assumption that 58 watts are lost per square metre of the body surface by the metabolism of a sitting-resting subject in a normally ventilated room, Peirce and Rees give an interesting set of values of "comfort" temperature for different thicknesses of clothing fabric and for different radii of curvature of the exposed surface.

The thermally effective specific volume of a woven fabric gives a measure of the insulating efficiency of the material (cotton, wool, etc.) for that particular structure of fabric. The use of a close-weave, wind-resistant, cotton fabric as a shield to the fabric under test produces a marked increase in the thermal resistance of the latter. The urea-formaldehyde resin treatment of fibres results in a large increase in the thermally effective specific volume and the treated viscose rayon and cotton have roughly the same efficiency as Java kapok.

For low-density fleece, the thermal resistance approaches that of still air and cotton fleece is much more efficient than rubberised hair sheets as a thermal insulator.

Results of tests of thermal transmission at high wind-speed on materials with windproof coverings are also given. S. R.

Chlorine Dioxide

Chlorine dioxide is rapidly finding a place among the more important oxidizing and bleaching agents. Its widespread use in the past was retarded by the lack of economical and convenient sources of the gas. Availability of chlorites in commercial quantities has made possible the plant-scale generation of chlorine dioxide in several ways. Three methods are described for the small-scale generation of chlorine dioxide, based on the gaseous chlorine-solid chloride process (*Ind. Eng., Chem., Ind. Ed.*, 1945 September). The selection of the method for any specific application depends on the purity of the chlorine dioxide desired, the amounts needed, the feasibility of batch or continuous production, the accuracy of control required, and the partial pressure of chlorine dioxide needed in the ClO_2 -air mixture generated. All three methods produce chlorine dioxide at low partial pressures at substantially atmospheric pressures and temperatures.—*U.S.I.S., Chem. Eng. and Chem. Newsletter*, 1945, No. 15.

Improved Wetting Agents from Alcohols

A newly patented process has as its objective increased production of purer sulphated fatty esters, which are used as wetting, penetrating and emulsifying agents in the textile industry. The end products are said to be clear, oily liquids that produce clear aqueous solutions and have remarkable foaming properties even in highly attenuated dilutions (*Chem. Industries*, 1945 Sept.). The new process consists of two steps. The first is to produce a low molecular weight alkyl fatty ester by reacting a mono- or polyhydric alcohol, such as ethanol or butanol, with an unsaturated or dihydroxy fatty acid in the presence of a catalyst such as alkylated naphthalene sulphonic acid. (In place of the lower alcohols, their esters, such as ethyl acetate or ethyl formate may be used.) The final sulphated fatty ester is produced by adding a complex alcohol or ester having ether, ketone or amino groups in its molecule. This mixture is treated with a sulphating agent, and after the reaction is complete, the resulting product is washed with a solution of sodium chloride and neutralized.—*U.S.I.S., Chem. Eng. and Chem. Newsletter*, 1945, No. 15.

Shellac Adhesives and Cements

Shellac is the main component of cements and adhesives used for joining smooth surfaces of glass, mica, metal-plates, etc. De Khotinsky cement, Pettman's cement used in munitions work and micanite insulators are well-known examples of industrial applications. New and improved compositions for bonding have been described by N. N.

Murty in an article entitled "Adhesives Based on Shellac and its Derivatives" (*Plastics*, 1945, 9.) It has been found that incorporation of hydrolized lac, mica or slate-dust and hydroxy acids like tartaric and malic acids brings about a considerable increase in adhesion strength. Several useful recipes are given and twenty possible industrial applications listed.

Paludrine

Paludrine, the new anti-malarial drug produced by the *Imperial Chemical Industries*, is N_1 -*p*-chlorophenyl-*N*₅-isopropylbiguanide, and is used in the form of a salt, for example, hydrochloride. The new drug is claimed to be ten times as powerful as quinine.

The cost of treatment by paludrine is expected to be appreciably below that by mepacrine, the synthetic anti-malarial drug used during the war. Semi-scale manufacture is already going forward at Blackley, Manchester, and will later be extended at Grange-mouth, Scotland, where *I.C.I.* erected a new plant for manufacturing mepacrine during the war.

Dr. D. G. Davey, a member of the *I.C.I.* team of scientists who first synthesised the new drug, recently completed a tour of Australia, India and Ceylon.

Dairy-Feed

"Natural pastures have long been the main source of feed for the New South Wales (Australia) dairying industry. The result has been extreme dependence on seasons, violent fluctuations in production, poor returns, and general instability of the industry," observes G. L. McClymont, Veterinary Officer of the Department of Agriculture, in a departmental pamphlet just issued.

"This reliance on natural pastures and seasons, and neglect of fodder conservation, is related to many factors. Chief among these have been the low price for dairy products and the relatively high cost of pasture improvement and fodder conservation machinery. Improved prices for dairy products and organization of farm machinery pools have largely removed these obstacles. The gateway to rapid improvement in the financial returns and stability of producers has been reached. Better, heavier, and more scientific feeding is the key to that gate."

The average butter-fat production from New South Wales herds is about 150 lbs. (equivalent to about 370 gallons of milk) per head per year, but the potential average—that is, the average which could be obtained by good feeding, is probably about 250 lbs. (about 600 gallons of milk per year). In the metropolitan areas, where feeding is better than average, production is about 660 gallons per head. This level might not be economic in butter-fat areas, but there is not the slightest doubt that heavier and better feeding with higher average production—possibly 220 lbs. of butter-fat or 500 gallons of milk per year—would mean greater financial returns to dairymen.—*Australian Agricultural News letter*, Feb. 46.

Geophysical Prospecting in India

An electric investigation on the foundations for a dam in the Damodar Valley is being undertaken by a geophysical prospecting party organized by the Geological Survey of India. Another prospecting party has been carrying out for the last two months a "spontaneous polarization" survey on what is believed to be a pyrites deposit. Both these parties will use mainly equipment constructed at the Geological Survey. A third party, using magnetic instruments,

which the Survey of India has agreed to give on loan, will start work within the present field season.

These investigations have followed upon the setting up, under Dr. G. Dessau, about six months back of a geophysical section under the Geological Survey of India. Dr. Dessau has specialized in the study of mineral deposits and has devoted considerable time during the past 20 years to geophysical investigations. In spite of the difficulties of getting specialists and suitable equipment, a good start has been made.

The investigations already begun or about to be started have been chosen mainly from the point of view of the availability of equipment and for their value in giving training to the personnel; and the geophysical section of the Geological Survey of India will, probably for a few years to come, devote itself mainly to work in connection with water-supply and dam foundation problems and the investigation of metalliferous deposits. Simultaneously, the applicability of geophysical methods to the study of some of the coal-bearing areas of India is also being investigated, although geophysics has till now generally been unsuccessful in this particular field.

Standardization of Soil Testing

The need to evolve standard methods and equipment for various tests necessary in the study of soils was emphasized by Rai Bahadur A. N. Khosla when he inaugurated at Lahore on 27th February, 1946, the first meeting of the Permanent Committee set up by the Central Board of Irrigation in its last annual session. The Committee consists of representatives of the Central Board of Irrigation, the Indian Roads Congress, the Railway Board and the Army in India. Dr. Asghar of the Punjab Irrigation Research Institute is its Secretary but its permanent office will be in charge of the Secretary, Central Board of Irrigation.

Referring to the tasks before the Committee, Mr. Khosla, who is the President of the Central Board of Irrigation, said: "You have to evolve standard methods for the various classes of tests and then devise standard equipment for carrying out those tests under the conditions existing in our country. Relevant standards in use in other parts of the world might serve for guidance," said Mr. Khosla, "but the knowledge available at present was insufficient to lay down final standards." He urged, therefore, the setting up of interim standards which could be modified from time to time. He drew the attention of the Committee to the need for standardization of nomenclature used in connection with soils so that experience gained in one part of the country might be useful to a study of similar problems in other parts.

Mr. Khosla recalled the words of H.E. the Viceroy in opening the Silver Jubilee session of the Institute of Engineers, India: "I consider that there is also a great need for research institutes so that India may not be dependent on discoveries made abroad and can make her own research into her particular problems, of which those dealing with water are the most urgent and vital." Mr. Khosla observed that what applied to research applied also to the setting up of standards. The Railways maintained a Central Standards Office and the Central Waterways, Irrigation and Navigation Commission and the Indian Roads Congress were setting up organizations to evolve suitable standards in their own spheres of activities. The proposal of the Central Board of

Irrigation to form this Committee had been welcomed by Railways, Roads and the Army in India.

Milk Supply in India

Mr. R. A. Pepperall, Chief Executive Officer of the *British Milk Marketing Board*, toured India last year as Milk Marketing Adviser to Government. His terms of reference were to make a rapid survey of the problems involved in the supply of milk to Indian cities, particularly the procurement, transport, processing (if any), quality and price control aspects; to make recommendations for both short-term and long-term policies and to prepare, if possible, a detailed scheme for organized marketing of milk to a large town, particularly in relation to Bombay and Delhi.

The Report submitted by Mr. Pepperall describes the present degree of efficiency of the Dairy Industry throughout India as "probably the lowest in the whole world." It observes, however, that a point which immediately impresses an investigator accustomed to the elaborate organization of producers, distributors and manufacturers which exists elsewhere is "the entire lack of any recognized channel through which matters affecting the industry can be represented to those in authority; similarly to find that official appreciation of its importance has been on such a low level as to admit of the destinies of the dairy industry being entrusted as a part-time occupation to the veterinary services." At the same time, the Report attributes to the general public "almost total apathy in a matter which affects their health and, incidentally, their pockets."

On the subject of feeding of dairy animals, the Report says this should consist of roughage such as hay, a sufficiency of green fodder and suitable concentrates. "The state of semi-starvation to which they are exposed is the main reason for the very low milk yields in India, and the quickest way to increase them can be found in the adequate feeding of the animal whereby an immediate reward of 100 per cent. or more in milk yield can be assured."

The Report has suggested that in every Province a Milk Commission should be set up with a Commissioner, a paid Director and Advisory Board nominated by Government, and at the Centre a co-ordinated milk policy as part of an All-India food policy should be adopted and implemented through a Central Milk Director. He urges that Directors of Milk should be recruited from overseas and given salaries of not less than £3,000 per annum as it is hard for Indians to take the drastic and unpopular action necessary.

Other recommendations are: (1) the cow should be developed for dual purposes—milk and draught, (2) cattle from city stables should be dislodged and colonized in more natural environments, (3) *Berseem* should be grown more extensively than at present in irrigated areas, (4) village areas should be utilized for cultivating and feeding green fodder in preference to grazing, (5) a total ban should be imposed on the export overseas of oilseeds and cakes from India, (6) dairy appliances and utensils of uniform standards should be manufactured in India, (7) the existing legal standards for pure milk should be re-examined, (8) the activities of the Military Dairy Farms should be restricted with regard to the manufacture of milk products and their export, (9) manufacture of milk products should be confined to remote rural areas, (10) the export of cattle from the Punjab to Bombay and Calcutta for milk production should be replaced by the export of evaporated milk manufactured in

the Punjab, (11) manufacture of butter in India should be discouraged; instead, it should be imported from New Zealand and other Dominions, (12) cheap milk should be provided for priority consumers, (13) producers should be organized into co-operative societies, (14) the manufacture of dairy products should be controlled by licensing, (15) modern dairies should be established in cities, and (16) dairy farms should be established.

Measures Taken to Improve Milk Supply

The Government of India have invited the attention of Provincial Governments to these recommendations and have stressed the need for expediting action on such measures as have not received adequate attention so far. Schemes have already been drawn up in some Provinces for the setting up of a Milk Control Board and appointing Dairy Development Officers. But the suggestion for the importation of Dairy Directors has not been endorsed.

Mr. Pepperall has suggested that experiments should be conducted on the feeding of fish to cattle for supplementing the existing available cattle feeds. The fish produced in India is required for human consumption and cannot be available for cattle feed.

Soil Erosion in Australia

Australia's first attempt to map and classify erosion on a large unit area—600 miles on the eastern side of Spencer's Gulf in South Australia, a typical wheat area—has been completed by officers of the Council of Scientific and Industrial Research.

Alteration of present land use practices is recommended as the only effective control. Specific recommendations are:—

Stocking rate adjustment, with lower stocking rate on natural hill pastures; three or four-year rotation of wheat-growing; contour banks on arable and furrows on grazing lands to minimize run-off and increase infiltration; retention of stubble.

Sisal Hemp Project

On a coastal belt of barren country worth only a rupee an acre, near Yanchep, Western Australia, an industry is planned by Mr. E. G. Haworth of Geraldton, West Australia. Mr. Haworth claims that enough sisal hemp could be grown there to supply the whole of the State, and later, the Commonwealth.

State Agriculture Department experts are now investigating the economics of sisal cultivation in the Yanchep area. Sisal fibre, till the outbreak of war, was imported to Australia from South Africa and Java, at an average cost of Rs. 321 to Rs. 375 a ton.—*Australian Agricultural Newsletter*, Feb. '46.

Indian Central Cotton Committee

Important matters relating to Indian cotton were discussed at the meetings of the Indian Central Cotton Committee held from 28th January to 2nd February, 1946. The meetings were attended by representatives of the various interests concerned from all parts of India, Sir Herbert Stewart, C.I.E., Vice-Chairman, Imperial Council of Agricultural Research, presiding.

The Committee unanimously passed the following resolution:—

"The *Indian Central Cotton Committee*, after a careful review of the statistical position of Indian cotton and of the plan for cotton production for 1946-47, is of the opinion that from the purely

cotton standpoint an extension of the cotton acreage is highly desirable. In view, however, of the gravity of the food position in the country, the *Committee* strongly recommends to the Government of India that all Provincial Governments and States be required to take whatever steps are necessary to restrict the cotton acreage for the season 1946-47, so that it may not exceed the acreage sown in 1945-46. In making this recommendation, the *Committee* is aware that the maximum acreage suggested is below India's minimum domestic requirements of raw cotton and cotton seed for cattle feed.

"In order that the sacrifice involved, if effect is given to the above recommendation, may not be in vain, the *Committee* urges that every avenue should be explored to increase the yield per acre. In this connection, the *Committee* recommends that, amongst other measures which may be considered necessary to attain the object in view, (1) special arrangements should be made for the import, to the maximum extent possible, of fertilizers which should be made available in large quantities to growers, particularly of foodgrains, at more favourable concessional rates than at present, (2) every transport facility should be provided for the movement of manures in the present food situation of the country, and (3) the crushing of oilseeds in the country should be stepped up rapidly with a view eventually to prohibit their export altogether."

The adoption of measures for the improvement of cotton yields in India came in for a good deal of discussion. The problem of raising the yield per acre of cotton in India has been engaging the attention of the *Indian Central Cotton Committee* almost from the time of its inception. Some success in this direction has already been achieved, as will be evident from the fact that the average yield per acre rose from 96 lbs. in the quinquennium 1922-27 to 109 lbs. in the quinquennium 1937-42. The average yield per acre during the triennium 1942-45 was 112 lbs., the figure for 1944-45 being probably a record at 122 lbs. per acre. Nevertheless, compared with other cotton growing countries—in Egypt and the U.S.A. the yield per acre of cotton in 1944-45 was 516 and 293 lbs. respectively—the yield per acre in India is still very low. It was agreed that whatever successes had been achieved so far was largely due to the extension of the area under irrigated cottons and the improvement of the race of the plant, and that there was little doubt that the yield per acre was capable of considerable improvement by the application of rational methods of agriculture. This was all the more necessary now in view of the impending competition from synthetic fibres; in the battle of fibres, the chief factor in the survival of cotton would be the cost of production. To safeguard the position of cotton growers, therefore, it was highly necessary that the yields should be raised. After extended discussion, the *Committee* recommended that investigations should be carried out in every region at a suitable farm representing the soil-climate complex of such region to ascertain what set of treatments produced maximum yields in respect of cotton irrespective of cost. It would then be for the administrations concerned to ascertain which factors contribute to the greatest increase in yield in the regions concerned. It was agreed that investigations were also necessary in regard to the part played by trace elements in cotton yields and it was accordingly recommended that such investigations should be

undertaken without further delay. The *Committee* further recommended that two or more suitable officers possessing basic knowledge of agricultural conditions in India should be sent to the U.S.A. for a period of one or two years to study cotton cultivation and the economics of cotton production.

The *Committee* approved of a new scheme for breeding Egyptian and Sea Island cottons in Sind at a cost of Rs. 84,000 spread over a period of five years. Several schemes for distribution of pure seed of improved varieties of cotton were extended for a further period. The *Committee* decided to make an annual grant of Rs. 1 lakh to the *Institute of Plant Industry, Indore*, for a period of five years for the purpose of running the *Institute* as an Agricultural Research Institute for Central India dealing with cotton (including cotton genetics) and its rotation crops, such as gram, juar, linseed, wheat, etc., and for providing a two-years' course for training in agriculture, horticulture and animal husbandry up to the Diploma standard.

The Third Conference on Cotton Growing Problems in India was held in the Board Room of the Indian Central Cotton Committee on the 4th and 5th February 1946, Mr. D. N. Mehta, O.B.E., B.A. (Oxon.), presiding. The Conference was attended by cotton research workers from all parts of India as well as by representatives of local science colleges and some 25 members of the Indian Central Cotton Committee. Forty-three papers, covering all aspects of cotton research, viz., cotton breeding and genetics, cotton technology, cotton statistics, cotton agriculture and cotton pests and diseases, were read and discussed. The role of science in the future development of Indian cotton and of Indian agriculture as a whole to provide for the needs of the country for clothing and food was emphasized. The Conference unanimously resolved to recommend to the Indian Central Cotton Committee that the stage had now been reached when immediate steps should be taken to set up permanent cotton research stations on a regional basis in all the cotton growing areas of the country. The Conference attached considerable importance to the payment of adequate remuneration to scientific workers and to the permanency of tenure. It was felt that permanent cotton research stations would provide the necessary nucleus for cotton research on a long-term basis and that the various schemes of the *Committee* could be much more suitably worked from one or other of the stations most appropriately situated. In addition the scheme would provide a reasonable degree of permanency of service to the *Committee's* employees who could be transferred from one station to another as required by the exigencies of the service.

Indian Lac Research Institute

"As a result of the last three years' work in a Bihar Government forest, it appears possible to undertake lac cultivation in forest areas as a source of revenue," states the six-monthly Report of the Indian Lac Research Institute for the period April to September, 1945.

Further work on shellac moulding powders has shown that their flow and the finish of moulded articles are improved if heat-polymerised C.N.S.L. (cashew-nut-shell liquid) is incorporated in them.

Lac, C.N.S.L. and casein taken in suitable proportions form a stable emulsion useful for impregnating jute-felt, hessian and various fabrics which may afterwards be moulded into bowls, dishes, etc. The emulsion reacted with furfuraldehyde gives rise to a

varnish suitable for preparing waterproof flexible coatings on paper, cloth, etc.

A combination of lac with C.N.S.L. modified by adding small quantities of drying and non-drying oils, and dissolved in solvent naphtha or toluene and reacted further with urea and formalin gives rise to a resinous composition fit for use as varnish.

The Report once again emphasizes the necessity of quick disposal of harvested crop, as also of water-immersion or heat treatment of the stick lac, before marketing, for the purpose of eliminating the lac predators and parasites that continue to grow in the harvested lac.

Indian School of Mines

Big demands for admission into the Indian School of Mines, Dhanbad, and for the services of qualified coal mine managers are recorded by the Annual Report of the Working of the Indian School of Mines, Dhanbad, for 1944-45. 2,518 candidates sought admission into the School in 1945. Of these 394 were selected for the entrance examination after which 48 were enrolled as students for 1945-46.

Research work was carried on in the washability and grading of coal. X-ray examination of Indian coals was continued and three original papers on geological subjects were contributed by the staff. The total number of scholarships held by students during this year was 71.

Hides, Skins and Leather

The problems connected with the export of hides and skins were discussed in New Delhi on 9th February 1946, at a conference convened by the Commerce Department. The Hon'ble Sir Azizul Haque, Commerce Member, presided, and about 50 representatives of trades associations interested in hides and skins and manufactures thereof from the different producing or trading centres of the country attended the conference.

The general opinion was that it was more desirable to export processed goods than the concerned materials in their raw state. It was, however, suggested that exports of the surplus should be permitted because without exports India could not import the necessary capital and other goods which she might require for her well-being and economic progress. India should take advantage of the favourable opportunity at present available in several markets, particularly in the Middle East countries, which were hungering for the country's products, both raw material and finished goods.

The following broad indications emerged from the discussions:—

1. As a result of the war, the leather economy of the country had undergone a radical transformation. India's tanning capacity and capacity to manufacture leather goods had considerably increased, in consequence of which she was able to absorb in her tanneries and factories much more raw hides and skins than what was possible before the war. Consequently, from the point of view of the needs of her present internal economy, it might not be possible for her to export as much raw hides and skins, unless increased supplies were forthcoming.

2. There was not much demand locally for heavy hides.

3. As the export demand for raw hides and skins, tanned hides and skins and leather manufactures was considerable at present, every encouragement should be given to their export, consistent with the needs of the internal economy of the country.

4. India's leather industry was on a cent per cent basis geared to the war effort during the war. Its expanded capacity to produce should be fully utilized, consolidated and developed, both to meet internal needs and export demand. It was pointed out that Indian leather goods compared very favourably in quality and finish with the best products of the West.

5. In addition to the development of organized tanning industry, tanning as a cottage industry expanded considerably during the war, thus giving remunerative employment to thousands of workers. It was necessary, in order to ensure continued employment in the future, to foster this industry, the product of which, it was claimed, was of a superior type, by making available to it the raw material adequately.

Basic Plan for Oilseeds

A conference of representatives of Provinces, Administrations and Indian States was held in New Delhi recently under the chairmanship of Mr. Marar, Joint Secretary, Food Department, to formulate a uniform policy throughout India with regard to the control of edible seeds, oil and oilcake in view of the overall shortage of edible oils and fats in the country. The conference favoured the adoption of a Basic Plan for oils and oilseeds with co-ordination of prices and a satisfactory system of procurement. There was also general agreement regarding the necessity for controlled distribution of cotton seeds.

The representative of the Commerce Department of the Government of India quoted figures showing the gradual decline of exports of oilseeds but emphasized the necessity of continuing some exports in view of the world shortage of fats and oils and India's requirements of cereal imports to be secured in exchange.

The Government of India will, it is understood, attempt to supply to each area the kind of oil to which it has been accustomed, and where this is not possible, substitute oils will be provided.

Trade Prospects in East Africa

"East Africa already possesses an economically sound Indian commercial community with long-established traditions in the country. India has the advantage for marketing in East Africa through the very large number of Indian retailers who have direct day-to-day contact with African shopkeepers and consumers. In view of these, and having regard to the purchasing power of the African population as the potential buyers of Indian manufactures, India should be able to enjoy a good share of the trade, provided her manufacturers made efforts to supply the exact type of goods suitable to these markets at competitive prices." So observes the latest report from the India Government Trade Commissioner, Mombasa, on the prospects of trade between India and the East African territories.

East Africa, the report observes, has always been a natural market for India owing to its proximity to this country and the character and economic life of its people. With the elimination of Japan and Germany as potential competitors for Indian manufactures in the East African market, "the day has dawned for India, to come in possession of her natural inheritance. Very few countries can perhaps provide a more stable market for Indian manufactures than the African territories, particularly East Africa."

A Competitive Market

Although Japan and Germany have been eliminated, the East African market, according to the report, is nonetheless a competitive market. Besides the U.K. and the U.S.A. making a bid for the market, China would be a potential competitor in the long run because, under Japanese occupation during the war, Manchukuo and Occupied China had been highly industrialized. In Shanghai, the Japanese had trained the Chinese in cotton textiles, while in Hongkong and Canton quite a number of secondary industries like hosiery, embroidered children's frocks, linen goods, electric torches, etc., are understood to have come up just prior to their fall into Japanese hands.

The possibilities of competition from local industries are reported to be negligible. The East African Governments are, of course, taking considerable interest in creating and developing secondary industries in East Africa, but as these industries, which had sprung up under the stress of the war are yet in a state of infancy, it will take a long time before they are able to compete with imported goods both in quantity and quality.

But in order to capture and retain the market, it is necessary, according to the report, that India should study the exact requirements of that market and effect improvements in its business methods.

The report then discusses the export possibilities of cotton piecegoods and ready-made clothes, such as shirts, shirt collars, suits, coats, trousers, etc., silk dress fabrics of various designs and qualities, and jute goods. The prospects for exporting these goods appear to be bright. There appears to be a good market for soaps and patent medicines. For leather manufactures such as shoes of all kinds, bedroom slippers, attache and suit cases, satchels, money purses, belts, *chappals*, etc., India can be assured of an expanding market in East Africa. There is also a good market for a wide range of lower priced enamelware from India like basins, rice plates, bowls, jugs, mugs, etc., and for building hardware and household fittings. Other articles which have a fair chance in the East African market are cutlery, crockery, glassware, biscuits and confectionery, matches, toys, hosiery, stationery articles, knitting wool, cotton thread, acids, batteries for motor cars, cells for torches, brooms and brushes, paints, colours and varnishes.

Import Duties on Industrial Raw Materials Removed

"As indicated by the Hon'ble Finance Member in the course of his budget speech, the Government of India have had under consideration for some time the question of removal or reduction of the import duties on certain raw materials required by Indian industries, as an effective means of assisting them in their post-war plans," says a *Press communique* dated 8th March 1946. As a result of this examination they have decided that the import duties on the following articles should, with immediate effect, be wholly removed:—

(1) Wooden blocks, cut to shape and size, for shuttle and bobbin manufacture; (2) manila hemp, raw; (3) piglead; (4) copper, unwrought; (5) celluloid, raw, for the manufacture of dressing combs; (6) asbestos, raw including fibre; (7) wood for the manufacture of pencils; (8) tanning extracts required for the tanning industry; (9) dum nuts for the manufacture of buttons; (10) mineral oils, white and half

white, for the manufacture of insecticides; (11) raw materials other than glass bulbs, required for the manufacture of electric lamps; (12) bristles for brush making and (13) carbon black for the manufacture of printing ink and black paint.

They have also decided that the import duty on fittings for umbrellas, parasols and sunshades should be reduced to 15 per cent. *ad valorem*.

Manufacture of Textile Machinery in India

According to a report appearing in *Capital* (7th February 1946), the Committee of representatives of textile industry set up by the Department of Planning and Development which met at Delhi early in February, recommended that India can and should manufacture textile machinery in this country. The Committee considered the question in the light of both short-term and long-term demand for textile machinery. It was explained that India's four hundred textile mills needed immediate renovation and rehabilitation and would require a great deal of new machinery for the purpose. In addition to this, a large number of mills, say 100, are due for erection in different parts of India. In other words, the proposed industry is assured of an immediate home market. Furthermore, this demand will be continuous as worn-out machinery and plant will require replacement.

The proposal is to launch the new industry on a co-operative basis, all the existing textile mills being its shareholders. The Government of India will give every possible assistance to the new industry.

Decimal System of Coinage

Decimal system of coinage is proposed for India in a Bill which the Finance Member, Sir Archibald Rowlands, introduced in the Central Assembly on 18th February.

The rupee, half-rupee and quarter-rupee would, under the Bill, be equivalent to 100 cents, 50 cents, and 25 cents, respectively.

During the transition period both the anna and the cent coins will circulate side by side, and prices might be quoted in terms of either. As it is not proposed to issue cent coins of a smaller denomination than a half-cent, the Bill provides for conversions involving smaller fractions to be made in rupees at the nearest half-cent and where the amount involved is a quarter-cent to the nearest half-cent below.

The existing series of small coins below four annas, which were introduced as a war-time expedient, have proved unsatisfactory and unpopular and the large recoinage programme which their reversion to the pre-war standards entails, offers a unique opportunity for introducing a decimal system, says the Statement of Objects and Reasons. "Modern trade and commerce demand speed and simplicity in the methods of computation, to achieve which there is nothing to compete with the decimal system which had gradually displaced all other systems in most of the advanced countries in the world. Public opinion has expressed itself largely in favour of the adoption of decimal coinage in India and the object of the Bill is to amend the Coinage Act for this purpose."

Within six months of the Central Assembly passing the Bill, cent coins and their multiples will be in circulation throughout the country.

The ten, five, and one cent coins will be made of cupro-nickel, the alloy of which the present 2-anna

and 1-anna coins are made. Decimal coins of higher denomination will consist of the same alloy of which the rupee, half-rupee and quarter-rupee are now made.

American Road Experts Visit India

With the concurrence of Provincial Governments, the Government of India have invited two top-ranking Public Works and Road officials from the United States.

The two officials are Major-General Philip B. Fleming, the head of the Federal Public Works Administration and Mr. Thomas Harris MacDonald, head of the Federal Bureau of Public Roads.

In view of India's programme for large-scale road development and of the heavy expenditure involved, information on current road engineering practice in other countries and friendly and independent criticism of the programme cannot fail to be of value. The technical and administrative problems connected with road planning and construction in India have much in common with those of the United States, and India is, therefore, fortunate in being able to obtain the advice and suggestions of these two experts, who are not only directly concerned with the planning of like development in the United States, but have an international reputation.

British Aviation Experts for India

The Civil Aviation Office of the Government of India is being expanded to meet the requirements of the programme for the development of India's air transport services and civil flying. As a first step towards this, three specialist officers have been recruited in England. These officers who have taken up their appointments in Delhi are Air Vice-Marshal Sir Edward Rice, who becomes Deputy Director-General (Aircraft); Air Commodore E. I. Bussell, who has been appointed Director of Licensing, and Mr. J. P. Jeffcock, who becomes Director of Communications. Mr. Jeffcock is on three years' contract while both Sir Edward Rice and Air Commodore Bussell are on five years' contract.

World Association of Nuclear Scientists

A proposal for the formation of a world association of physicists and nuclear scientists, with a view to do away with the threat of warfare by atomic bombs, has been made by Dr. Gardon F. Hule (*Science*, 1945, 102, 672). The proposal will come up before the American Physical Society and affiliated societies at their forthcoming meeting in New York.

The members of the proposed Association are required to subscribe to the following principles: (1) respect for and confidence in the labours of all its members irrespective of nationality, (2) a pledge not to give advice concerning, or assist in making atomic bombs, (3) a pledge to continue research in fundamental physics including the physics of the nucleus of atoms, all atoms, (4) to publish the results of such research, (5) to assist in experiments leading to the beneficial application of atomic energy to human problems, and (6) to welcome the physicists of other nations to our laboratories. The Association would not be regarded as formed until 90 per cent. of the physicists of every major nation as determined by the principal Physical Society of that nation, had subscribed to the principles and accepted membership. The holding back by the physicists of any major nation would release all tentative members of this pledge.

Development of Scientific Research

A meeting of the Standing Finance Committee was held on 23rd February 1946, the Hon'ble Sir Archibald Rowlands, Finance Member, presiding, at which proposals for development of scientific research, Andamans Forest Department Reconstruction Scheme and grant-in-aid to the Institute of Art in Industry, Calcutta, were approved.

Scientific Research

One of the proposals concerning the development of scientific research related to the expansion of the Electrical Technology Department of the Indian Institute of Science, Bangalore, by establishing a High Voltage Engineering Laboratory at a non-recurring cost of Rs. 23,13,000 and a recurring cost of Rs. 36,000 in 1946-47 and Rs. 45,000 a year in subsequent years.

The establishment of this Laboratory would assist electrical development in the country and the growth of knowledge of electrical theory and application and provide substantial employment for skilled labour, particularly for the re-employment of war technicians.

Another proposal of the same nature related to a four year development programme of the Indian Institute of Science. It was proposed to open new departments in the Institute, viz., a General Chemistry Section in the Department of Pure and Applied Chemistry, a Department of Metallurgy and a Department of Internal Combustion Engines. The total non-recurring expenditure of the development scheme would be Rs. 40,00,000 and recurring expenditure Rs. 2,25,000 in 1946-47 rising up to Rs. 3,59,000 a year in the subsequent years.

A third proposal was concerned with the appointment of Indian Scientific Liaison Officers in the U.K. and the U.S.A. The Committee was informed that the main function of these officers would be to disseminate information in regard to scientific research in these countries. The annual expenditure would be Rs. 97,000 in the U.K. and Rs. 88,000 in the U.S.A. in 1946-47 and Rs. 1,50,000 and Rs. 1,75,000 respectively a year in the subsequent years. The Committee approved the scheme in a modified form.

Timber for Commercial Exploitation

The Andamans Forest Department Reconstruction Scheme would involve a capital outlay of Rs. 42,31,000 and a recurrent expenditure of Rs. 14.3 lakhs in 1946-47 and Rs. 42 lakhs a year in the subsequent years if the target of timber output rose to 72,000 tons a year. It was pointed out to the Committee that the Andamans forests constituted a valuable asset of the Government of India, possessing at least 1,500 sq. miles of forest classed as "forests which afford a supply of valuable timber for commercial purposes." Timber was in great demand at present and would be for some time, for reconstruction and industrial development. It was, therefore, considered essential to market the Andaman timber before competitors exploited the available markets.

Handloom and Sericulture Industries

The proposal further to extend the grant-in-aid of Rs. 5 lakhs to the handloom industry in 1946-47 was approved.

An additional grant of Rs. 1,24,375 was also approved in respect of the research work by the Central Sericultural Research Station, Berhampur,

This station, it was stated, was carrying on sericultural research, mainly in respect of maintenance of disease-free pure stocks of approved indigenous and foreign races of silk-worms and diseases of silk-worms. Including this additional grant, the total recurrent expenditure of this scheme which, it was explained, was for a period of five years, from March 1943 to February 1947, would now be Rs. 69,250 non-recurrent and Rs. 1,74,860 recurrent or Rs. 2,44,110 in all.

A third proposal of a similar nature related to the creation of a Silk Directorate for price and distribution control and expansion of silk production at a recurrent expenditure of Rs. 35,300 in 1945-46 and Rs. 1,40,000 a year in subsequent years.

Financial Help to "Art in Industry"

The proposal to give a grant-in-aid to the Institute of Art in Industry, Calcutta, involved a grant to the Institute of Rs. 45,000 in 1945-46, Rs. 75,000 in 1946-47 and Rs. 1,25,000 in 1947-48. The activities of the Institute, it was stated, would be, *inter alia* :

- (a) to undertake widespread exhibitions and displays, both for original work and for India's most attractive goods (including handicrafts);
- (b) to have advisory panels in India and representatives in all principal cities abroad, thus keeping in touch with world developments in design and commercial art, and disseminate this information in India through a magazine and technical bulletins, etc.;
- (c) to compile a register of commercial artists and designers together with examples of their work, and award Diplomas, Associateships and Fellowships to deserving candidates; and
- (d) to maintain the high standard of traditional Indian handicrafts and assist craftsmen in producing those wares which are likely to be in demand, and display them to the public.

PATRA Activities, 1944-45

Research of considerable value to the printing and packaging industries has been carried out in the laboratories of the *Printing and Allied Trades Research Association*, U.K. The Annual Report for the year 1944-45, which has just been received, records briefly these activities. The *Association* has had to work under great difficulties during the war years, and although it was established in 1937, the research staff had favourable conditions for work only for a brief period of two and a half years. Dr. G. L. Riddell, Director of Research, rightly observes that it is usually found in research, that there is an initial period during which the ground has to be cleared and it is only when this has been done, that results begin to flow rapidly in increasing volume. Now that the "ground has been cleared" it may be confidently expected that more spectacular results will be forthcoming as a result of the activities of this *Association*.

Important work on the *quality of lithographic plate grains* has been carried out by the *Association*. The appreciation of a grain has depended hitherto on visual inspection and other qualitative tests based on the experience of the observer. For the first time, an attempt has been made to define grain in a precise manner. Three properties of the grain were selected for quantitative measurement, viz., the surface area, the pore volume and the depth. The surface area is the total metal surface exposed by the graining

process, the pore volume gives the maximum of water that can be held by the plate during printing and the depth of the grain is important when considering the anchoring of images, particularly albumen images, to the plate. On the depth of the grain also depends the wearing quality of the plate.

For measuring the area the method employed is to take a mould from the plates in cellulose acetate or nitrate, cut into small squares and deposit a thin film of silver on them. Hydrogen peroxide is decomposed by the silvered squares under controlled conditions. The amount of decomposition is a measure of the area of contact between the silver and hydrogen peroxide. The heat emissivity of the litho plate, which depends upon the area of the hot surface, also gives a measure of the area. It has been found that the results obtained by the two methods agree to within a few per cent. The surface area of litho plates is about 2½ times the superficial area for 80 grain plates, and about 5½ times for 150 grain plates.

The pore volumes can be measured by a simple displacement method. The pore volumes decrease from 25 cc./sq. metre for 80-grain plates to 10 cc./sq. metre for 150-grain plates.

An improved process for *electrotyping moulds* has been worked out in the laboratories. The accepted practice of rendering the wax moulds conducting is by means of powdered graphite. This has many disadvantages. First, it is not a clean process; next, it is time-consuming and the resulting mould is not highly conducting. It has been found possible to disperse graphite in a liquid and then spray it on the wax moulds. This process has definite advantages over the dry powder method, although the electrical conductivity is still no greater than that obtained by the old process. Plastics are likely to find use as moulding media in place of wax, and studies are now in progress on the methods of applying metallic films in place of graphite. It has also been found possible to produce conducting silver films in wax and from wax moulds so treated, it is possible to obtain satisfactory electrotypes.

Immunity Bulletin

We welcome the first number of the *Immunity Bulletin*, issued by the Immunity Scientific Association, Calcutta. It is a classified record of the researches carried out in the Bengal Immunity Research Laboratory, Calcutta, since its establishment upto April 1945.

The *Bengal Immunity Co., Calcutta*, has a well organized research department and the original papers issued from it are published in several Indian scientific journals. During the Silver Jubilee Celebration of the *Bengal Immunity Co.*, held on 10th May 1945, Sir J. C. Ghosh, the Chief Guest, spoke appreciatively of the research activities; he said "The Managing Director, by earmarking 25 per cent. of the net profits for the promotion of research . . . has fallen in line with the most enlightened business executives in England and America." The *Immunity Bulletin* is a record of the research work resulting from this enlightened policy. The work is classified under five groups. Forty-six papers on chemical research are summarized in the first group under the sections analytical, synthetics, and pharmacy and pharmaceutical chemistry. This is followed by a classified summary of 31 papers under biochemical research, 18 papers under biological research, 28 papers under pharmaceutical research, and 14 under clinical research. The *Bulletin* is well got up and the Immunity Scientific Association

deserves to be congratulated on its success in presenting a very readable account of the research activities of the *Bengal Immunity Co.* Further numbers of the *Bulletin* will be awaited with interest.

Dictionary of Economic Products and Industrial Resources of India

The following contributions have been received from external contributors up to 31st January 1946:—

Botany

Economic uses of lichens (K. Biswas); *Zingiber officinalis* (K. S. Murti and C. R. Moosad); Davana oil (S. G. Sastry); *Cinnamomum camphora* (K. S. Murti and C. R. Moosad); *Arachis Hypogaea* (C. M. John); *Curcuma zedoria* (K. S. Murti and C. R. Moosad).

Chemistry

Sulphuric Acid (A. Nagaraja Rao); Hydrochloric Acid (A. Nagaraja Rao).

Geology

Alkaline lakes and soils (M. R. Sahni); Borax (M. R. Sahni); Titanium minerals (C. S. Pichamuthu); Tin (A. B. Dutt); Bentonite (K. L. Bhola).

Industries

Refractory Industry in India (H. K. Mitra).

Announcements

World Power Conference. A meeting of the International Executive Council of the World Power Conference, at which about twenty countries were represented, was held at the Euston Hotel on 20th and 21st November 1945. The Council decided to hold, if possible, a sectional meeting in 1947 to discuss the general question of fuel economy and to resume publication at the earliest feasible date of their *Year Book* containing information on all sources of energy. They also resolved: "In view of the future significance of atomic energy over the whole range of power problems, this Council resolves to appoint a small committee to watch developments and to make recommendations to the International Executive Council of the World Power Conference as soon as it is practicable to have an effective discussion on

the utilization of atomic energy for industrial and domestic purposes." (*J. Roy. Soc. Arts*, 1945, 94, 74).

United Nations Educational, Scientific and Cultural Organization. The Central Legislative Assembly accepted, on 16th April, Sir John Sargent's resolution recommending to the Governor-General-in-Council to accept the constitution of the *United Nations Educational, Scientific and Cultural Organization*. Sir John said that the advantages of pooling the educational resources of the world, which the U.N.E.S.C.O. sought to do, would be undeniable. India, with her high traditions of culture and history, would, on the one hand, be able to make her contribution to a world assembly of this kind while, on the other, she would also gain a good deal by closer association with the progressive educational policies of other countries. Sir John also made the point that by joining the U.N.E.S.C.O. now, India stood to gain a good deal more. The first conference was to be held some time in summer or autumn next year when elections to the executive body would be held. She could press her own claims for representation on that body effectively, right from the start.

Royal Society of London. As we go to press, we have received information that Brigadier J. A. Sinton, V.C., Consultant Malariologist of the War Office, has been elected Fellow of the Royal Society of London. Brigadier J. A. Sinton as Director of the Malaria Survey of India has made outstanding contributions to the knowledge of all aspects of malaria.

Erratum. Our attention has been drawn to certain errors in the figures for power output of hydro-electric schemes in India. The errors are regretted. The correct figures are given below:

1. This *Journal*, 1945, 3, 526, L. H. column:—Note on "Dam Across Godavari."—The power proposed to be generated is 75,000 k.w. continuous, and not 750,000 k.w. continuous as printed.
2. This *Journal*, 1945, 3, 536, L. H. column:—Note entitled "Hydro-Electric Schemes."—The figure for total output of existing installations should read 1,000,000 k.w., which includes 500,000 k.w. of hydro power and 500,000 k.w. of steam power.

Obituary

(Continued from page 606)

Royal Asiatic Society of Bengal and was also awarded the Sir William Jones Medal of this institution. He was a recipient of the Griffin Memorial Prize, the Coates Medal, the Minto Medal and the Buckley Medal for his brilliant researches. He twice presided over the medical and veterinary sections of the *Indian Science Congress* (1930 and 1938) and was also the General President of the *Indian Science Congress* in 1936. He was a Foundation Fellow of the *National Institute of Sciences of India*, of which he held the office of the Vice-President.

He has written several books. His *Studies*

in *hemolysis* is regarded as an important contribution to physiology even to-day and his *Gleanings from his researches*, in two volumes, published in 1940, are a source of great inspiration to workers in chemotherapy. His articles on chemotherapy of quinine compounds, organic antimonials and other topics are masterly contributions and give a brilliant exposition of the subjects dealt with.

Brahmachari will always be regarded as one of the pioneers of chemotherapeutic research in India and his work will act as a stimulus to all workers for many decades to come.

M. L. SCHROFF.

Reports from States and Provinces

Review of Post-war Planning and Development

BEFORE he left the Government of India, after 18 months of office, Sir Ardeshir Dalal carried out a review of the progress made by the Central and Provincial Governments in post-war planning and development. An account of the review is now available.

Not only have many of the plans, both of the Central and Provincial Governments, reached the blue-print stage, but quite a number of them are being actively pursued and executed. All-India plans and policies in respect of education, agriculture and food, roads, railways and civil aviation have been announced, whereas those regarding such subjects as health, labour, publicity, etc., are in an advanced stage of preparation. Special bodies to deal with certain important aspects of development have been constituted at the Centre, the most important of which are the Central Technical Power Board and the Central Waterways, Irrigation and Navigation Commission. These bodies have already taken a prominent part in planning the Damodar Valley schemes and are considering the question of the control and development of the Sone, the Kosi, the Mahanadi, the Teesta and other rivers. The demand for their services at present exceeds their capacity. An organization for advising on the layout of factories and factory inspection has been set up. Measures for the health insurance of workers have been prepared and other labour questions, such as hours of work, the recognition of trade unions, etc., are under investigation, while a special staff has been built up to deal with roads, civil aviation, agriculture, labour, education, etc.

Training Schemes

As a first step towards development, training schemes have been actively pursued. About 600 students were selected for advanced technical training overseas during 1945-46. Unfortunately owing to the difficulties arising out of the necessity of transporting demobilized troops, the despatch of the students has been considerably hampered. Over a hundred technicians from different industries have also been selected for advanced training in factories in the U.K. and the U.S.A.

Scientific Research

A plan for widespread expansion of scientific research activities has been initiated. The first of a series of five national laboratories, namely, the Ceramic and Glass Research Laboratory, was recently inaugurated in Calcutta. The other laboratories, the plans for which are going ahead, are the National Chemical Laboratory at Poona, the National Physical Laboratory at Delhi, the National Metallurgical Laboratory at Jamshedpur and the Fuel Research Station near Dhanbad.

Special priority has been given to the "Grow-More-Food" Campaign. Though it is difficult to estimate the actual results obtained, an additional outturn of 750,000 tons of foodstuffs has been estimated as the ultimate result of these measures. Seven thousand tube wells are being sunk and over 3,000 tanks and 4,000 other minor irrigation works are under construction.

Schemes for the employment of demobilized soldiers and their settlement on land and in industry have been given special priority and have made considerable progress in all the Provinces.

Central Plans

The Central Government scheme for the five-year development period includes a five-crore scheme for Delhi Province, a railway programme involving a total expenditure of Rs. 319 crores in seven years, of which about 20 per cent. is hoped to be spent in 1946-47. The Civil Aviation plan involves an expenditure of Rs. 6 crores, of which 60 lakhs is proposed to be spent in the coming year. The total cost of the national highways, which it is hoped will be the responsibility of the Centre, comes to about Rs. 70 crores over a period of 10 to 15 years; the amount to be spent in the next year will depend upon the reports of the Provinces. The Posts and Telegraphs programme is of the order of Rs. 12 crores, of which Rs. 4 crores will be spent in 1946-47. The Agricultural Department proposes to set up a Central Agricultural College and an Animal Husbandry College and to establish a central agricultural service. The Forest College at Dehra Dun has been expanded. Facilities for research on different types of crops, fishery, marketing, etc., are being provided and it is proposed to set up a Council for Co-operation and a Soil Conservation Bureau. The Education Department is proceeding with the development of a number of technical institutes, which include four all-India institutes of technology on the lines of the M.I.T., the first of which, it is hoped, will be started next year. Other proposals include a Central Engineering College, a college for teachers in technology and domestic science and a college for physical education. A high grade military academy on the lines of "West Point" in America to train officers of all the three services is to be set up as a War Memorial. Provincial Governments are similarly expanding their existing training institutions or putting up new ones.

Provincial Five-Year Plans

The total cost of the Provincial plans, excluding N.W.F. Province, comes to Rs. 900 crores. The Bengal Plan is of the order of Rs. 160 crores, while the plans of the five Provinces, Madras, Bengal, Punjab, U.P. and Bihar, are each over the Rs. 100 crore mark. The proposed expenditure of the Provinces under the various major heads is as follows:—

P.W.D. Rs. 466 crores (including Roads Rs. 246 crores, Irrigation Rs. 146 crores and Electric Power Development Rs. 20 crores); Education Rs. 104 crores; Medical and Public Health Rs. 90 crores; Agriculture Rs. 85 crores and Industry (to the extent to which it is financed by Government) Rs. 22 crores. The points from which the Provincial plans will be examined by the Central Government are financial and administrative practicability, balanced development of the various subjects with due regard to the priorities laid down and conformity with the all-India policies and objectives.

During his tenure of office, Sir Ardeshir Dalal toured all the Provinces with the exception of the N.W.F.P., several of them more than once. These tours have been recognized as of great value in

removing difficulties, promoting co-ordination and establishing closer co-operation between the Central and Provincial Governments.

Anti-Deflationary Measures

The sudden termination of the war, the early commencement of demobilization and the contraction of war expenditure are all factors which render it necessary to pay special attention to measures for counteracting deflation and unemployment during the transition period. From that point of view, the Central Government has requested all Provincial Governments to put up urgent interim plans consisting of schemes selected from their five-year plans for immediate execution. The importance of selecting productive schemes providing a high degree of employment relative to costs such as roads, irrigation, buildings, etc., has been emphasized. The Central Government has promised to advance to the Provinces upto 100 per cent. of the expenditure as well as assistance in raising loans, the advances to be recovered from the Central subventions to be paid to the Provinces during the quinquennium beginning 1st April, 1947. Practically all the Provincial plans have been received and are being examined. The total expenditure, including loans, proposed for the interim plans is of the order of Rs. 75 crores, which would go some way towards counteracting deflation.

Co-operation With Provinces

These schemes have been based on the objectives laid down in the different plans such as for education and agriculture and are not merely an haphazard collection of unco-ordinated projects. The individual provincial schemes still remain to be put into a co-ordinated whole in accordance with all-India targets and objectives and this work will be undertaken by the Centre in co-operation with the Provinces. It would have been quite possible, *a priori*, to have prepared long-term Central and Provincial plans and then split them up into different schemes. Such work to be of more than theoretical value would have taken a long time whereas, on the basis adopted by the Government of India, a large number of schemes are ready and are being put into execution, particularly with a view to combating deflation. This procedure also enables a clearer appreciation of the targets and objectives to be made than would have been possible under the more theoretical procedure.

Among the measures for combating unemployment and deflation, the scheme for promoting building takes an important place. Steps have been taken to make material more freely available for private building and the facilities for financing such activities are being studied. In regard to industrial housing, the Government of India is preparing a scheme with the ultimate objective of building two million houses in ten years with the help of subsidies from the Central and Local Governments.

Industrial Policy

An industrial policy for the country has been framed and was issued in the form of a statement in April, 1945. This statement sets out the objectives of the industrial policy, the place of the State in industrial development, the need for planned industrial progress and the necessity on the one hand for controlling industry in the public interest and on the other hand for a wide measure of State encouragement and assistance. The principles and policy enunciated in the statement have received a

large measure of support. It is interesting to note that there is a substantial measure of agreement between the statement and the industrial policy as announced in the blue-print for a free India enunciated by Pandit Jawaharlal Nehru, the Chairman of the National Planning Committee. The statement is being considered in consultation with the Provinces and the States from whom also a large measure of support has been received. When these consultations have been concluded, it will be possible to proceed to legislation for the central control of certain industries of national importance and the establishment of Licensing and Investment Boards. While these questions are under consideration, practical problems of planned development that have arisen in the meanwhile have been dealt with: for example, a detailed plan which has been drawn up for the textile industry on a regional basis has been broken down further and quotas settled for States and Provinces. Likewise the cement plan has now been adopted, quotas fixed for States and Provinces and the allocation is being made. The needs of industrially backward Provinces and States have been particularly taken into account in the allocation of quotas.

Industrial Blue-Print

Having settled a working policy, the next step is to prepare an industrial blue-print for India. With that object, a large number of industrial panels have been established and they have been asked to make recommendations for a detailed phased plan for five years as the first stage of a fifteen-year plan of industrial development. It took some time to form the panels because in the selection of personnel due weight had to be given to specialized industrial experience. Considerable difficulty was also experienced in securing the required staff; but, once started, all the panels, with the exception of two or three, have made satisfactory progress and the reports of a large number of them, including the important panel on the steel industry, are expected within the next two or three months while a few reports have already been received.

In the meantime, industrial progress has not been held up. It has been the object of the Planning Department to encourage private enterprise to go ahead, but, in doing so, care has to be taken to see that the plans of private industry are not likely to be in serious conflict with the ultimate plan of industrial development that may be laid down in consultation with the Provinces and States. That raises the important question of capital issue and other controls.

Government have decided that in order to provide them with the data for planning and to enable them to assist industry, all applications for import of capital goods must be registered. This scheme has been functioning since December 1944 and Government have now got complete information as regards the plans of the private industries during the next few years as a result both of the registration scheme and the administration of capital issues.

Mineral Resources

Very closely allied to industrial development is the question of developing the mineral resources of the country. Special attention has been devoted to this object. Sanction has been accorded to the expansion of the Geological Survey to nearly four times its original permanent cadre and in pursuance of this sanction, it has actively been expanded to over

twice its old strength. Steps are being taken to recruit foreign experts as well as to train Indian geologists by extending the facilities for geological education in India and sending them for further training overseas. A new all-India mineral policy is being framed and the question of setting up a separate Mines Bureau is under investigation. Committees to deal with the problems of coal and mica have been set up.

Capital Equipment

During his recent visit to the U.K. and the U.S.A., Sir Ardeshir Dalal discussed with the various authorities the possibilities of obtaining capital equipment. As a result of his tour, the two countries have taken a more widespread and practical notice of India's desire to industrialize herself and of her need for technical equipment as well as technical assistance. To further this aim and to help Indian industrialists to obtain capital equipment, an India Supply Mission has been set up in the U.K. and a similar Mission in Washington has been strengthened. The task of investigating the possibilities of obtaining capital goods suited to the requirements of India from the large American war surpluses has been assigned to the Mission at Washington.

Surplus Machinery

Pending the large-scale import of capital goods which under present conditions is likely to take two to three years more, the best hope of starting industrialization in India is in the utilization of the surplus machinery and equipment available in some of our well equipped Ordnance Factories. That is being looked into earnestly by Government and some of the factories have already been turned to work for civil purposes.

Industrial Finance Corporation

To help in the financing of private industries, a project for the establishment of an Industrial Finance Corporation somewhat on the lines of the similar body in the U.K. has been discussed with the Reserve Bank of India and the Corporation is expected to be set up in the near future. It would also be possible to start similar corporations to help smaller industries in the Provinces once the all-India Corporation comes into being.

It would thus be seen that in spite of serious difficulties, political and administrative, and particularly the difficulty of obtaining suitable personnel, very substantial progress has been made in all fields of development and the lines for further progress have been laid out.

United Provinces

The cessation of hostilities has envisaged an era of brisk planning of post-war industrial development.

The exigencies of the war provided an excellent opportunity for the expansion of industries in general. The various control measures worked satisfactorily and prices of essential commodities showed declining tendency.

The Model Industries, Dayal Bagh, Agra, were able to manufacture biological charts with a grant-in-aid from the Department.

The U.P. Industrial Financing Corporation, Ltd., Cawnpore, which was receiving a subsidy from Government for advancing loans to industrialists

could not function properly and has now been closed.

War Supplies.—The Department organized the manufacture and supply of several articles, e.g., handloom blankets, wooden and metal whistles, locks, scissors, safety pins, spoons, etc., of the value of more than Rs. 40,60,000 in 1944-45 and provided employment to about 30,000 cottage workers.

U.P. Government Handicrafts, Lucknow.—This institution continued to push the sales of cottage products. Goods worth Rs. 6 lakhs were sold during 1944-45. Agencies were established outside U.P., in the cities of Delhi, Bombay, Madras, Calcutta and Rawalpindi.

Technical Assistance and Research.—Technical advice was given to a number of industrialists and private concerns. Research was conducted on the manufacture of D.D.T.

Technical Education.—Enrolment in most of the institutions dropped due to the circumstances created by the war, but the results and the standard of training remained satisfactory.

The following was the position at the end of 1944-45:—

	No. of institutes.	No. of students.
Government Institutes	23	1,153
Aided Institutes	72	1,726

Civil Supplies Scheme.—Till September 1944, over 1,700 tons of agricultural implements were fabricated and distributed to licensed dealers in the province for sale at controlled rates. This scheme was later substituted by production through trade, and about 570 tons of goods were manufactured by the end of March 1945.

Standard Weights Scheme.—The Department undertook the manufacture of standard weights at the Government Technical Institute, Lucknow. Weights of varying denominations weighing about 3,400 maunds were made and supplied to different districts in the province.

Cotton Handloom Scheme.—The production of standardized fabrics yielded satisfactory results. The total production in 1944-45 was worth about 3.25 lakhs.

Wool Scheme.—Two special schemes for the development of the wool industry are under operation in (a) Almora/Naini Tal and (b), Garhwal, Najibabad. New and more attractive designs were introduced and marketed through the Government U.P. Handicrafts.

Glass.—Improved types of furnaces were built during the year. Glass articles mostly bottles to the value of over Rs. 27.25 lakhs were supplied to the Government of India, Railways, Military Bodies, Red Cross Societies, etc.

Commercial Intelligence Section.—The Commercial Intelligence Section has been reorganized and expanded to collect commercial intelligence and explore the possibilities of industrial development of this Province. The collection and compilation of statistical data of various manufacturers and minor industries of U.P. and the work of preparation of an authentic *Commercial Directory* has been taken in hand.

The Department has organized an industrial design competition with a view to introducing better designs in cottage products and making them available to the industrialists and cottage workers for mass production.—(Contributed.)

Holkar State

Plans in Progress

It is gratifying to note that the Holkar State has not only carefully "planned" but has also begun to successfully execute its plans. Among its several post-war schemes, high priority has been given to agricultural research. It may not be known to many that in Indore is located one of the foremost agricultural research institutes of India, popularly known as the *Plant Institute*. For some time past, there has been a feeling, and perhaps rightly, that the *Institute* is not doing all that it could to promote agricultural research in India in general and Central India in particular. This was largely due to the slender finances at its disposal. The *Indian Central Cotton Committee* has now been persuaded to increase its annual contribution to one lakh of rupees from 1st June 1946; in addition to this, the Holkar State has promised to make a substantial contribution, so much so the additional annual funds at the disposal of the *Institute* would be to the tune of Rs. 2 lakhs and with the help of this amount it is expected that the *Plant Institute* would become a really first class research centre for cotton. In fact, it is hoped that Indore will be for cotton what Coimbatore has been for sugarcane. Those who know about the importance of cotton in Central India, and more particularly in the Holkar State, can realize the value of this research institute to the agriculturists; improved cotton would mean not only more money to the cultivator, but better cloth to the consumer and more profits to the Holkar State industrialists. Another important step in the expansion of the *Plant Institute* is the addition of a

first rate agricultural school. Steps have been already taken to open a Diploma course in the *Plant Institute* from July 1946. Towards this end, certain buildings at present used by the military are to be transferred to the *Plant Institute*. This has been rendered possible, thanks to the enthusiasm and the help of the Resident.

Another plan of far-reaching importance is the linking of the city of Indore to the broad-gauge line. The proposal is now ready and is in fact in an advanced stage of development. The idea is to open a broad-gauge line connecting Indore to Duskheda near Bhusaval via Mhow, Manpur, Maheshwar, and Khargone on the one side, and Indore to Tarana via Dewas on the other. This scheme would provide the much needed broad-gauge connection to Indore on both sides, one at Duskheda near Bhusaval on the G.I.P. Railway and the other at Tarana Road on the B.B. & C.I. Railway. The proposed alignment of this scheme passes through the biggest, and in some respects very rich, districts of the Holkar State. If this plan succeeds, Indore which is already a very important industrial centre in Central India will become one of the major industrial centres of India.

Considerable progress has also been made in the scheme for the establishment of a first rate Medical College in Indore. There is already a Medical School, the staff of which has some eminent medical men. The school is supported not only by the Holkar State but also by a number of other States in Central India. The scheme for the Medical College is to receive support not only from Indore but also from the neighbouring States. In addition to this, the State is also planning to have a fully equipped Hospital to give adequate practical training to the students of the Medical College. (Contributed.)

MULBERRY HARBOUR*

ONE of the most spectacular achievements of British engineers in the last war is what is known as the "Mulberry Harbour." A harbour could be a natural one, a semi-natural one or an entirely artificial one. The Mulberry Harbour fell into the last category. There were two, one for the British and one for the Americans, all entirely artificial, built on a beach which had no natural protection at all.

In May 1941, on the fall of France, it was realized that no conquest of Europe could be successful by merely walking and that it had got to be a battle all the way. It was at that time that Sir Bruce White was called to the War Office and asked to act as Director of Ports.

An organization was soon built up to deal with maritime problems in every form and to design special equipment to meet every conceivable task with which they might be confronted and which had to be carried out with the minimum of delay. They explored every possibility and designed specially locked gates which would replace those blown up and could be put in a matter of days instead of 18 months or 2 years which was normally the case.

They explored the breakwaters of the floating type, the fixed type and piers in every form of construction and it involved designing, ingenuity and originality. They built up an organization of many engineers with special experience in all special branches. At that time they had no definite problem to solve. But the problem they had on the other side of the coast was indeed a great one, because Hitler had referred to it in two speeches.

The turning point came when the great war leader, Mr. Churchill, in 1942 came forward with a very strong request that they had to have unloading facilities in the beaches. "We want harbours that could float up and down with the tide," he said, "anchor problem must be solved. Let me have the best solution worked out. Don't argue. The difficulties will argue themselves out."

This was a very clear directive which made men work. This directive came up for discussion at a meeting held at the Combined Operation Headquarters at which all the services were present. Within 7 days they had the solution on paper to that problem by one of the most remarkable team of designers. The design got on very well. They were

* From an address delivered by Sir Bruce White at the Central India Centre of the Institute of Engineers (India), New Delhi on 22nd February, 1946.

able to get the prototype of the pierhead which weighed 1,000 tons and the roadway in pontoons, all in 4 months' time from the start. They had the design through early in 1943. They had the pierhead and the roadway on to its test side in a lonely part of Scotland where it could be subjected to storms. The storm came. They had an anxious time, but the pierhead stood, the roadway stood and they knew that they had the solution. That was in June 1943.

In 1943 came the deciding point in the whole operation—the Quebec Conference, at which the plan was decided. The Quebec plan was to make attack on part of the coast which was undefended. The actual problem they had was to design the supply and components for building two harbours, one for the British and one for the Americans, identical as to materials—in all about a million tons of special equipment. The components must have to be ready for 'D' Day for towing to France to enable the harbours to be built there in 144 days from the starting date—the harbours to give protection to large ships, coasts and landing crafts and provide the usual amenities including discharge facilities. The rate of discharge from the ships was to be 7,000 tons a day in the British harbour and 5,000 tons in the American harbour; in addition, 2,500 vehicles a day were to be discharged. The harbours were to withstand 90 days of summer weather. That was the problem. The whole of the problem had to be tackled and accomplished in about 7 months. The time factor was the vital point. Pier-heads and roadway had to be designed; special buffer pontoons had to be designed and before they could embark upon this breakwater unit, one had to consider every aspect, depth of water, possibility of towing such a mass in rough seas, etc.

On the supply side the task fell to the Ministry of Supply who were the suppliers of the War Office of every one of their requirements. The War Office provided all the designs; the Ministry of Supply was responsible for the building. This was a big contract, one of the biggest that the world had ever known. Everybody worked feverishly—many worked themselves literally to death but they were all imbued as a team with the absolute necessity of getting this done. Strict secrecy was maintained throughout. It was done partly by making parts in different works; the roadways and other works were prefabricated in no less than 300 works. In not one work was any complete part built and it was only when it was delivered, 150,000 tons of it, at the South Coast and erected in two depots with military labour that it became complete.

Then 'D' Day came. That was indeed a time of suspense, because all their ingenuity, originality, everything had been put into that equipment. In this operation it was taken over by the Navy who played their great part. The project was a great success.

Due to a severe storm from the 13th day after 'D' Day for 48 hours, the American harbour suffered grievous damage; it could not be used; much of the material was recovered for use in the British harbour. The British harbour was put right and continued to work and reached a tonnage of 11,000 tons, whereas the target was only 7,000.

Many were engaged on this work—all classes of engineers. War, terrible as it is, offers to the engineer opportunities which he can usefully employ in peace time, because he is called upon to do things which have never been done before on a vast scale regardless of expense and within the shortest time.



(British Ministry of Information)

Part of the Mulberry Ports exhibited at Liverpool.

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for February, 1946. Patents from the *Council of Scientific and Industrial Research* are indicated by an asterisk.*]

28284. INSECTICIDE : *Containing a rotenone-containing vegetable root and a high boiling tar acid or medicinal paraffin in an inert powder carrier.*—Cooper McDougall & Robertson Ltd.
28305. GLYCEROL : *Glycerine containing aqueous solution is mixed with a solvent for glycerine and heated so as to distil off the water with the solvent.*—The Distillers Co., Ltd. Brittain, Joshua and Whitmarsh.
30664. HEAT EXCHANGE DEVICES : *Brazing a thin foil of alloy between two element in non-oxidising atmosphere to form alloy and cooling.*—I. C. I. Ltd.
30725. BRAZING THE ELEMENTS OF HEAT EXCHANGE DEVICES : *Brazing a thin copper foil between the two elements to be joined.*—I. C. I. Ltd.
31148. SHARPENING MEANS FOR SAFETY RAZOR BLADES OF THE DOUBLE-EDGED WATER TYPE : *Blade carrier slidable on honing surface and pressure-applying member.*—Chia.
31179. CENTRAL LUBRICATION OF MACHINERY AND VEHICLES : *Plunger of reciprocating pump is actuated by electric during means under the influence of control means which receives motion from the vehicle or machinery.*—Tecalmit Ltd.
32215. HASPS : *Upper part turned round to form an engagement member, the engagement portion of inverted channel shape.*—S. Tajbhai & Sons Ltd.
32264. ELECTRICAL CONTACTING EQUIPMENT FOR HOISTS, CRANES AND THE LIKE : *Travelling contacting device for movable appliances like hoists and cranes.*—Benbow.
32487. DARTS : *A dart flight comprises a pair of slotted elements of kite form which interengage and form a socket to receive the stem of the dart body.*—Giles.
32832. SPINNING FRAMES : *Thread plate pivoting about a pivotal point which is in vertical elevation below the top surface of the thread plate.*—Nicoll.
32836. MEASUREMENT OF ELECTRIC IMPEDANCES : *Connecting impedes in parallel with a variable condenser and applying alternating currents of different predetermined frequencies and tuning.*—Sheridan.
32931. ELECTRIC CABLES : *High tension electric cable with a laminated dielectric body built up of helically wound strips of polythene or of a mixture of polythene and polyisobutylene.*—Callender's Cable & Construction Co., Ltd.
32979. SELF-LOCKING NUT OR BOLT : *Integral and coaxial union of washer element with pressure face of nut or bolt but axially spaced from this pressure face by a neck with which washer element is united and provision of a bore in the washer.*—Pummill.
- *33114. PAINTS FROM MICA : *Mixing mica powder with zinc oxide and amyl acetate-celluloid lacquer.*—Ray.
33258. MAGNETIC CORES FOR TRANSFORMERS : *Interposing refractory material, between the turns of spirally wound strip, which fuses, at the temperature of heat treatment.*—Telegraph Construction and Maintenance Co. Ltd.
33259. TIMEPIECES : *An hour hand quadrant having two or more pointers differentiated by readily recognisable indications.*—Jayatileke.
33280. ELECTRIC SWITCHES : *Snap action provided by a transversely curved spring strip actuated by a bimetallic strip or push button.*—Thermega Ltd.
33333. ROLLING AND/OR CRUSHING TEA LEAF IN THE PROCESS OF MANUFACTURING TEA : *A part of the crush on the leaf is applied with the assistance of pneumatic pressure applying means.*—Nicholls.
33335. ALTERNATING CURRENT ELECTRIC TRANSFORMERS : *Three limb core with no winding on the middle limb; input to windings on one limb interrupted by switching means.*—Metropolitan-Vickers Electrical Co., Ltd.
31237. BAG : *Square-bottom bag is formed from a multiple-wall tube having a middle seam in the bottom and the bottom portions of the side walls folded to form two equilateral triangles.*—Wingfoot Corp.
31846. ALTERNATING CURRENT RECTIFIERS OF THE DRY SURFACE CONTACT TYPE : *Counter electrode of dry surface contact type has a small proportion of thallium added to it, is mainly composed of bismuth or lead.*—Westinghouse Brake & Signal Co., Ltd.
31847. ALTERNATING ELECTRIC CURRENT RECTIFIERS : *Counter electrode of selenium type rectifier composed of a layer of metal or alloy applied to the surface of the semi-conductor and a second layer of same metal or alloy containing thallium applied to the first layer.*—Westinghouse Brake & Signal Co., Ltd.
31848. ALTERNATING ELECTRIC CURRENT RECTIFIERS : *Counter electrode of dry surface contact type composed of tin cadmium alloy to which a layer of sodium or potassium is applied.*—Westinghouse Brake & Signal Co., Ltd.
31886. ALTERNATING CURRENT HOIST CONTROL : *Multi-phase hoist motor control comprising unbalanceable voltage means between motor and the supply and controlling means for the latter.*—Westinghouse Electric & Manufacturing Co.
32210. MICROPOROUS RUBBER OR RUBBER-LIKE MATERIAL : *Producing dough incorporating fine particles subsequently removing the same and vulcanising.*—Pritchett & Gold and E. P. S. Co., Ltd.
32437. PENICILLIN : *Cultivation of penicillin producing organisms in an aqueous nutrient medium under aerobic submerged conditions.*—Merck & Co., Inc.
32523. TIFFIN CARRIER : *Hoops being engaged in embosses and tightened by slipping lockers having slots.*—Chadray.
32637. TUBULAR LAMPS AND HOLDERS THEREFOR : *Contacts on one end of a tubular lamp connect in series, spaced contacts on an axially movable insulating member in the holder.*—International General Electric Co. of N. Y. Ltd.

32763. ENGINES, COMPRESSORS AND THE LIKE: *Oscillatory vanes carried by rotor follow undulating surfaces on stator; vanes afford abutment surfaces co-operating with the undulating surfaces and the periphery of rotor, provide working chambers for compression or power impulse operation.*—Debnam.
33008. REVERSING GEAR FOR STEAM LOCOMOTIVES OF ALL TYPES: *Automatic replacement of leakage of liquid from the hydraulic locking cylinder by fresh liquid from the supply.*—Beyer Peacock and Co., Ltd. and J. Hadfield.
- *33059. GAS CLEANING DEVICES FOR USE IN CONJUNCTION WITH PRODUCER GAS PLANTS: *Gas admitted at bottom of chamber, with cyclonic motion, and liquid at top, in a spray of wide angle; thin film of liquid formed on the walls.*—Das Gupta, Khanna, Nair and Dr. Verman.
33061. TUBE REDUCING MILLS: *Improvements provide two fluid operated one-way clutches to actuate feeding and turning mechanisms respectively in properly timed relation to each other.*—Rockrite Processes, Inc.
33081. WINDOW AND LIKE FRAMES: *Flanged channel section material with the ends of the sections mitred off are secured together to form the frame.*—Senior.
33131. REFINING OF HYDROCARBONS: *Desulphurising hydrocarbons under high pressure and temperature in presence of hydrogen and desulphurisation catalyst and recycling the hydrogen without desulphurisation in the reaction.*—Anglo-Iranian Oil Co., Ltd.
33248. BICYCLES: *Treadles alternately oscillating up and down with throw of 60° to 90° interconnected through free wheel mechanism.*—Podbielski.
33427. REFINING OF HYDROCARBONS: *Hydrocarbon heavier than kerosene and a naphthene passed over catalyst at elevated temperature and pressure.*—Anglo-Iranian Oil Co., Ltd.
33428. STOP MOTION FOR SPINNING AND LIKE TEXTILE FRAMES: *A detector unitary with a member affording a bearing for a knife-edge, a pivotal link connection with the said member and a lever connected to the link forming a toggle.*—Douglas Fraser & Sons Ltd. and Fraser.
33452. ADHESIVE BONDING OF SURFACES AND ADHESIVE COMPOSITIONS: *Adhesive bond between surfaces.*—B. B. Chemical Co., Ltd.
30831. VISCOUS PROTEIN SOLUTIONS FOR THE PRODUCTION OF ARTIFICIAL FILAMENTS: *Maintaining a solution of peanut globulin in alkali at an elevated temperature and then cooling to a lower temperature.*—I.C.I. Ltd.
30854. READILY CLEANABLE FILTERS: *Cage or like mounting carries scraper means and is disposed about the circumference of filter screen.*—Vokes Ltd.
30855. HEAT EXCHANGE ARRANGEMENTS MORE ESPECIALLY FOR USE WITH INTERNAL COMBUSTION ENGINES: *Intake air filter and lubricating oil cooler, one surrounding the other.*—Vokes Ltd.
30856. AIR FILTRATION: *Curved louvre plates, means deflecting outer layer of fluid and means collecting the particles carried by the fluid.*—Vokes Ltd.
31212. ACYLATED ALIPHATIC AMINO CARBOXYLIC ACID AMIDES: *Acylating N-monoalkyl or N-monocycloalkyl amino carboxylic acid amide with carboxylic acids or derivatives thereof.*—J. R. Geigy A.-G.
31213. AGENTS FOR COMBATING ANIMAL PESTS OF THE SOIL: *Using solutions, emulsions or suspensions of aromatic organic compounds which may or may not contain halogen sulphur or oxygen.*—J. R. Geigy A.-G.
31214. CONDENSATION PRODUCTS, BEING MORE ESPECIALLY ACTIVE INSECTICIDAL COMPOUNDS, AND FORMATION OF LIQUID AND DRY INSECTICIDES THEREWITH: *Containing condensation products of mono or a dihalogen aldehydes with compounds containing replaceable hydrogen atom.*—J. R. Geigy A.-G.
31253. DENSENITIZATION OF EXPLOSIVES: *Adding to a aqueous paste of the explosive a salt of an aliphatic carboxylic acid or an aliphatic or aromatic amine.*—I.C.I. Ltd.
31390. SLEEPING BAGS: *Blanket having buttons and button-holes is folded first longitudinally and then transversely.*—Muirhead.
31444. β -NITROETHYL ETHERS: *Reacting nitroethylene with an alcohol.*—I.C.I. Ltd.
31475. PHTHALOCYANINE DERIVATIVES: *Heating phthalic derivative with urea and a substance containing metal and then reducing.*—I.C.I. Ltd.
31627. A MACHINE FOR BENDING OR ROLLING SHEETS: *The bearing at one end of one of the three rollers moved to enable rolled sheet to be removed from this end and then refitted for further operation.*—Indian Steel & Wire Products Ltd.
31898. SETHOAM CELLULAR MATERIAL: *Employing chromium salt as a setting agent for the manufacture of cellular material from foamed alginate solutions.*—Sir Appleton, Rose, Plesch and Cetoil Ltd.
32007. INTERPOLYMERS OF CHLOROTRIFLUOROETHYLENE AND OLEFINIC HYDROCARBONS: *Interpolymerisation of chlorotrifluoroethylene and olefinic hydrocarbons in contact with a peroxy compound as catalyst at temperatures between 60° to 150° C. and at superatmospheric pressure.*—E. I. Du Pont de Nemours and Co.
32112. RAILWAYS: *Sleepers are fixed at an angle with the rail.*—The National Foundation Ltd.
32273. ELECTRIC CIRCUITS OR DEVICES INCORPORATING A NON-OHMIC CONDUCTING MEMBER: *Titanium oxide refractories arranged in series contact with each other to provide a circuit having non-ohmic current voltage relationship.*—Steatite & Porcelain Products Ltd.
32286. PRESERVATION OF NATURAL RUBBER: *Incorporating in rubber a secondary aromatic amine and an unsubstituted phthalocyanine or a metal complex of such phthalocyanine.*—E. I. Du Pont de Nemours and Co.
32339. SYNTHESIS OF IMIDAZOLIDONE COMPOUNDS: *Treating imidazolone ester with a saponifying agent, condensing with an acyl halide and reducing the product.*—Hoffmann-La Roche, Inc.
32468. CLEANING THE CARD CLOTHING OF THE CARDING CYLINDERS OF CARDING ENGINES: *Aspirating mouth pieces mounted close to the points of card clothing.*—Castell.
32574. LIQUID FUEL CONTAINERS FOR AIRCRAFT AND OTHER VEHICLES AND THE MANUFACTURE THEREOF: *Comprising an envelope, one or more accessory fittings and a cover secured adhesively adjacent to the fitting.*—I.C.I. Ltd.
32635. DOORS OF SAFES OR THE LIKE: *Flanges welded or otherwise secured to door slab and supported by stay plates.*—Godrej & Boyce Mfg. Co., Ltd.

ELECTROLYTIC REDUCTION OF NITRO COMPOUNDS

By B. B. DEY, T. R. GOVINDACHARI and S. C. RAJAGOPALAN

(Presidency College, Madras)

PART IV—THE ELECTROLYTIC REDUCTION OF *ORTHO* NITRO TOLUENE IN ALKALINE EMULSION

IN Parts I and II of this series¹ a detailed description of the preparation of benzidine by the electrolytic reduction of nitrobenzene in alkaline emulsion, first on a laboratory and then on a pilot-plant scale, was given. It was demonstrated conclusively that the electrolytic reduction of nitrobenzene in alkaline emulsion under certain specified conditions yielded excellent results and was superior to other electrolytic methods or chemical methods in ease of operation, yield and purity of product and low cost of production.

It was, therefore, considered necessary to examine the utility of this process for the production of the more valuable diamines belonging to the class of benzidine, like toluidine, dianisidine, diphenetidine and dichlorobenzidine.

Elbs² was the first to describe the electrolytic reduction of *ortho* nitro toluene. By reducing in alcoholic solution with the addition of sodium acetate, he obtained hydrazotoluene in 85-90 per cent. yield. Haussermann³ and Lob⁴, by employing a similar procedure, obtained hydrazotoluene in about the same yield. McKee and Gerapostolou⁵ reduced *ortho* nitro toluene in a concentrated solution of sodium and potassium xylene sulphonate and claim a yield of 80-90 per cent.

All other references to the electrolytic reduction of *ortho* nitro toluene are contained in patent specifications. Thus Wulff⁶ secured a patent for the electrolytic reduction of nitro compounds in an alcoholic solution of sodium acetate, *ortho* nitro toluene being one of the compounds covered by this patent. Other patent references dealing with the reduction of nitro compounds in alkaline emulsion generally make a statement that *ortho* nitro toluene is reduced in the same way as nitrobenzene with similar results and do not go into details. However, according to Dieffenbach⁸, considerable amounts of *ortho* toluidine (upto 30 per cent.) was formed in the reduction of *ortho* nitro toluene in alkaline emulsion. *Ortho* azoxy

toluene, on the other hand, gave exclusively the hydrazo-toluene. Dieffenbach secured a patent for the reduction of azoxy compounds to hydrazo compounds, the azoxy compounds being first formed by the interaction of hydrazo compounds with nitro compound. As a technical electrolytic method Dieffenbach's procedure is of doubtful value.

No systematic work on the electrolytic reduction of *ortho* nitro toluene in alkaline emulsion has been reported so far. In this paper an account is given of the work carried out on this problem. The studies were restricted to reduction at an iron cathode, since the most satisfactory results were obtained with this cathode in the earlier study¹ conducted on the reduction of nitrobenzene.

The reductions were conducted in the small oval iron cell of which a full description has been provided in Part I of this series¹. When 90 per cent. of the current required for reducing nitro toluene to hydrazo toluene had been passed, 200 c.c. of xylene were added and the reduction continued till the solvent layer was colourless. Thus in every case the nitro compound (except where otherwise indicated) was completely reduced to the hydrazo compound and the amine. The colourless solution containing the hydrazo compound and the amine was immediately treated with 2.2 molecular proportions of hydrochloric acid for effecting the "benzidine transformation." After separating the solvent and aqueous layers, the toluidine was precipitated as the sulphate, filtered, dried and weighed. The filtrate was basified and steam-distilled to remove *ortho* toluidine. The solvent layer was worked up for azotoluene formed by oxidation of hydrazotoluene during these operations.

Although hydrazo compounds can be estimated in alcoholic solution iodimetrically¹⁰, it will be readily understood that in the present study in which the products of reduction are removed by xylene, rapid and accurate estimations are not possible. Secondly, hydrazotoluene does not have any

intrinsic value apart from being an intermediate compound for the production of toluidine. Since the "benzidine transformations" have been effected under identical conditions, the yield of toluidine sulphate may be expected to furnish an accurate estimate of the amount of hydrazotoluene in the electrolytic reduction.

According to some German patents¹¹, the formation of hydrazo compounds is favoured by the use of tin, lead or zinc cathodes in an alkaline electrolyte or by the addition of the oxides of these metals to an alkaline electrolyte at a nickel cathode.

The effect of the addition of these oxides at an iron cathode is shown in Table I.

It is seen from the results (Table I) that—

- (1) At an iron cathode alone, the yield of toluidine sulphate and hence of hydrazotoluene is poor. The amount of toluidine is also large.
- (2) The addition of lead oxide helps in carrying the reduction of nitro toluene to completion and leads to hydrazotoluene in the maximum yield. Amine formation is not, however, suppressed completely.

TABLE I. 100 gms. *ortho* nitro toluene, 400 cc. of 10 per cent. sodium hydroxide solution, iron cathode, apparent current density 2 amps./sq.dm., Temperature 80°C.

Compound added		Total current amp. hrs.	Toluidine sulphate		Toluidine		Azotoluene	
Name	gms.		gms.	%	gms.	%	gms.	%
Nil	Nil	170*	26	22.9	29.5	37.8	16†	—
Lead oxide	10	140	53	46.9	20.0	25.6	2	2.6
Lead oxide	10	140	52	45.9	18.0	23.0	2	2.6
Lead oxide	20	140	51	45.1	18.0	23.0	8	10.4
Zinc oxide	20	157*	7	6.2	40.8	52.2	28†	—
Tin oxide	5	145*	22	19.5	27.5	35.2	30†	—

* The colour of the solvent layer was not discharged completely. Reduction was stopped when solvent layer had assumed a constant shade of colour.

† Mixture of azo and azoxytoluene, exact composition not determined.

TABLE II. 100 gms. *ortho* nitro toluene, 400 cc. of 10 per cent. sodium hydroxide solution, 10 gms. lead oxide at iron cathode at 80°C.

Apparent current density-amps./sq.dm.	Total current amp. hrs.	Toluidine sulphate		Toluidine		Azotoluene	
		gms.	%	gms.	%	gms.	%
1	115	52	45.9	18.6	23.7	3	3.9
2	140	52	45.9	18.0	23.0	2	2.6
5 till azoxy 1 after	127	49	43.3	19.3	24.7	3	3.9

TABLE III. 100 gms. *ortho* nitro toluene, 400 cc. of sodium hydroxide solution, iron cathode, 10 gms. lead oxide. Apparent current density 2 amps./sq.dm. Temperature 80°C.

Strength of alkali soln. %	Total current amp. hrs.	Toluidine sulphate		Toluidine		Azotoluene	
		gms.	%	gms.	%	gms.	%
10	140	52	45.9	18	23.0	3	3.9
20	125	54	47.7	18	23.0	—	—
30	125	44	38.9	21	26.8	—	—
50	125	47	41.6	19	24.3	—	—

TABLE IV. Reduction at iron cathode at apparent current density of 2 amps./sq.dm. 10 gms. lead oxide. Temperature 80°C.

<i>Ortho</i> nitro toluene gms.	Volume of 10% alkali c.c.	Ratio of depolarizer to catholyte	Total current amp. hrs.	Toluidine sulphate		Toluidine		Azotoluene	
				gms.	%	gms.	%	gms.	%
94.3	405	1:5	135	41	38.4	18	24.4	—	—
113.2	389	1:4	137	67	52.3	19.7	22.3	—	—
141.5	364.5	1:3	180*	77	48.1	29	26.2	7	6.5

* Colour of solvent layer was not completely discharged.

- (3) The addition of zinc oxide produces mainly toluidine and the yield of hydrazo compound is negligible. The reduction is inhibited in some way so that it is not taken to completion.
- (4) Tin oxide is also unsatisfactory in assisting hydrazo compound formation.

Since the best results were obtained with lead oxide, all further studies were conducted after the addition of this compound.

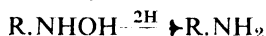
Influence of Current Density.—Only a few experiments were conducted on this aspect. The results are given in Table II.

It is seen that at a lower current density, there is a marked improvement in the current efficiency. However, the yield of hydrazo-toluene is not increased or that of toluidine diminished to any extent. It may be expected that at higher current densities, with the corresponding increase of cathode potential amine formation may predominate.

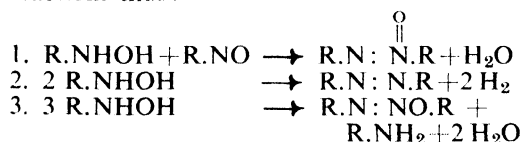
According to the Haber scheme, the nitro compound is first reduced to the nitroso compound and the latter being a better depolarizer is immediately reduced to the phenyl hydroxylamine derivative.



The phenyl hydroxylamine derivative may get further reduced to the amine thus:



Or it may get involved in further secondary reactions thus:



The velocities of the three reactions decrease in the order given and are all catalysed by hydroxyl ions. The speed of the first reaction will, therefore, determine the amount of azoxy compound and, therefore, of hydrazo compound at the end of the reduction. If due to any reason, the speed of condensation is diminished, the phenyl hydroxylamine will have greater chance of getting directly reduced to the amine. Since the concentration of alkali may have some bearing on the speed of condensation of nitroso with phenyl hydroxylamine derivative, the experiments in Table III were conducted.

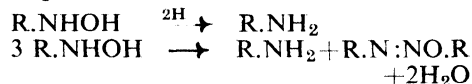
It is seen from the results above that although current efficiency is improved by increasing the alkali concentration, the yield of hydrazotoluene is reduced by using alkali of over 20 per cent. strength.

The experiments listed in Table IV were conducted to examine the influence of varying the concentration of depolariser.

It is seen that the best results both with regard to current efficiency and yield of hydrazo compound are obtained by operating with a depolariser ratio of one to four volumes of catholyte.

The most disturbing feature in all the reductions is the large proportion of toluidine which is simultaneously formed with the hydrazotoluene. Amines do not usually originate from the reduction of hydrazo compounds as this is very difficult. This is, of course, possible, but hardly likely to take place under the conditions employed in the cell.

Two possibilities are:



The formation of amines due to decrease in the speed of condensation of nitroso with phenyl hydroxylamine derivative is ascribed by Elbs¹² to steric hindrance in the case of some substituted nitro compounds as in the case of *ana* nitro *meta* xylo quinoline and *ana* nitro *ortho* toluquinoline. Amine formation may also be due to an increase in the speed of reduction of R.NHOH by the presence of hydrogen carriers or catalysts. In order to test the validity of the last supposition, the reduction of *ortho* nitro toluene was conducted at an iron cathode till sufficient current had been passed to reach the azoxy stage. It may be supposed that the speed of reduction at an iron cathode with its low over-voltage may not be high and would lead to the production of azoxy compound in good yield without the formation of amine. After this stage, lead oxide was added and the reduction continued to completion. Under these conditions, 100 gms. of *ortho* nitro toluene (400 cc. of 10 per cent. sodium hydroxide solution, apparent current density 2 amps./sq.dm., 150 amp. hrs. Temp. 80° C. gave on working up in the usual way, 35 gms. toluidine sulphate (30.9 per cent.), 23.5 gms. toluidine (30.1 per cent.) and 2 gms. of azotoluene (2.6 per cent.). It is thus seen that amine formation can take place in the case of *ortho* nitro toluene even at a cathode like iron and it is necessary to add the lead oxide at the commencement of the reduction to secure good yield of hydrazotoluene.

In another experiment, the *ortho* nitro toluene (100 gms.) was added in portions of 12.5 gms. at a time at approximately one hour intervals (iron cathode, 400 cc. of 10 per cent. alkali, 10 gms. lead oxide, apparent current density 2 amps./sq.dm., temp. 80° C.). Under these conditions the colour of the solvent layer was not discharged even after passing 235 amp. hrs. and on working up in the usual way, 13 gms. toluidine sulphate (11.5 per cent.), 38 gms. of toluidine (48.7 per cent.) and 29 gms. of azotoluene (37.8 per cent.) were obtained.

It appears from the results obtained in this study that it is difficult to suppress amine formation to any appreciable extent. Pellegrini¹³ in attempting the reduction of *ortho* nitro toluene and *ortho* nitro anisole in alkaline emulsion with sodium amalgam obtained the amines as the main products. But by conducting the reduction in alcoholic or pyridine solution, the hydrazo compounds were formed in good yields, although even under these conditions nearly 10 per cent. of amines were always formed. The formation of amines is due to the steric effect exerted by the methyl group on the condensation of nitroso with phenyl hydroxylamine derivative (cf. Elbs¹² and Bamberger¹⁴). However, according to Lob¹⁵, steric hindrance has nothing to do with amine formation and by proper adjustment of the cathode potential, any desired product can be formed. The cathode potential should be held at such a level that reduction does not proceed beyond the phenyl hydroxylamine stage. When all the phenyl hydroxylamine derivative is used up in forming the azoxy compound by condensation with nitroso compound, the cathode potential can be raised to a level where reduction of azoxy to hydrazo compound can take place. It is difficult to say how far this is practicable on a technical scale. Amines like toluidine or anisidine are not without value and their simultaneous formation along with hydrazo compounds need not render the electrolytic method for the production of the diamines unsound technically.

A more serious drawback is the large amount of *ortho* nitro toluene left unaccounted for in terms of toluidine sulphate, toluidine and azotoluene. Thus in a standard reduction, 100 gms. of *ortho* nitro toluene gave 53 gms. of toluidine sulphate (46.84 per cent.), 20 gms. of toluidine (25.63 per cent.) and 2 gms. of azotoluene (2.61 per

cent.), accounting for only 75 per cent. of the nitro compound taken. After removal of toluidine as the sulphate and the toluidine by steam-distillation after basification, a tarry residue which is completely basic is left behind. This amounted to nearly 17 gms. of material which could have been formed only during the "benzidine transformation." This product is being further investigated. Noeling¹⁶ obtained a by-product in the conversion of hydrazotoluene to toluidine, which he supposed to be ditolyline on grounds of analogy.

In order to estimate how far losses in the conversion of hydrazotoluene to toluidine, in the shape of secondary products, accounted for the low yield of toluidine, the hydrazotoluene was isolated in a few experiments. Benzene was used for removing the products of reduction from the cell. In one experiment, the benzene was removed *in vacuo* and the residue ground up with cold dilute hydrochloric acid sufficient just to remove about 20 gms. of toluidine which is the amount of toluidine usually formed. The yield of hydrazotoluene was 56.8 gms. (73.4 per cent.) and 19.6 gms., of toluidine (25.1 per cent.). In the second experiment, the benzene extract from the cell was shaken with just sufficient dilute hydrochloric acid to remove the toluidine. With care, it was possible to remove only the amine without submitting the hydrazo compound to "benzidine transformation." The benzene layer was then washed with water and the benzene removed *in vacuo*. The yield of hydrazotoluene was 56 gms. (72.4 per cent.) and of toluidine 19.7 gms. (25.2 per cent.). In both cases, the benzene extract was quite colourless when taken out from the cell, but during the subsequent handling gradually turned reddish. The hydrazo compound obtained was also slightly coloured and melted at 155-60° C. instead of at 165° C. On washing the product with methanol, a colourless product melting at 165° C. was obtained but the methanol also removed appreciable amounts of hydrazo compound along with azotoluene.

The hydrazo compound washed with methanol was submitted to "benzidine transformation."

- (1) 8.3 gms. of hydrazotoluene, 17 cc. of HCl (1.16), 25 gms. ice, 50 cc. xylene and 1 cc. of sodium bisulphite solution gave 11.05 gms. toluidine sulphate (91.6 per cent.)

- (2) 7.5 gms. of hydrazotoluene, 22.5 gms. HCl (1.16), 195 cc. water, 50 cc. xylene, 1 cc. of sodium bisulphite solution gave 9.5 gms. toluidine sulphate (86.6 per cent.). This experiment is based on the proportions prescribed by Ullmann¹⁷.
- (3) 10 gms. hydrazotoluene, 25 gms. ice, 50 cc. xylene, 18 c.c. HCl (1.16) gave 13 gms. toluidine sulphate (88.8 per cent.).

It is seen that it is unnecessary to operate with very dilute acid as prescribed by Ullmann¹⁷. With a lesser molecular proportion and higher acid concentration, better results are obtained. It is also seen that hydrazotoluene can be converted in over 85 per cent. yield to toluidine.

It was shown earlier that in the standard reduction, a little over 56 gms. of hydrazotoluene was formed for every 100 gms. of *ortho* nitro toluene. With a 85 per cent. yield in the conversion, this ought to give nearly 70 gms. of toluidine sulphate. However, when the xylene solution of the products from the electrolytic cell is submitted to treatment with acid straightaway only 53 gms. of toluidine sulphate were obtained. Assuming that 56 gms. of hydrazotoluene had been formed in the electrolytic reduction, the yield works out to 64.7 per cent. of theoretical.

In order to find out whether the presence of toluidine along with hydrazotoluene was responsible for lowering the yield in the conversion to toluidine, the xylene extract from the cell (100 gms. *ortho* nitro toluene) was divided into two equal halves. One half was treated with just sufficient acid to remove the toluidine and then submitted to conversion. The other half was treated with acid without removing the toluidine. The two halves yielded, 25 gms. toluidine sulphate, 9.7 gms. toluidine, 2 gms. azotoluene and 26 gms. toluidine sulphate, 10 gms. toluidine and 1 gm. of azotoluene respectively. The authors have so far been unable to account for the lower yield of toluidine obtained when the hydrazotoluene direct from the cell is submitted to conversion, than when a product washed with methanol is used.

Experimental

***Ortho* nitro toluene.**—Toluene was nitrated with a mixed acid of D.V.S. 2.5. The mixture of *ortho* and *para* nitro toluene was

fractionated *in vacuo* using a tall Raschig column with automatic dephlegmation arrangement. The first portion upto 40 per cent. of the distillate was essentially *ortho* nitro toluene. This was refractionated and gave *ortho* nitro toluene whose purity was found to be over 99 per cent. by the amine oxalate method¹⁸ and by colorimetric method¹⁹.

Electrolytic reduction of ortho nitro toluene.

—A full description of the electrolytic cell employed in this study has been provided in Part I of this series¹. A typical reduction was conducted as follows: The alkali of the specified strength was heated up with the addition agent (usually lead oxide) so as to dissolve the latter and introduced into the cathode chamber. The porous diaphragm, containing the iron anode was also filled up to the same level with 30 per cent. sodium hydroxide solution. The current was passed at 20 amps. for about 15 minutes, heating the cell at the same time. When the temperature of the catholyte was 80° C., the nitro compound (100 gms.) was added. The reduction was carried out at the specified amperage keeping the temperature at 80° C. During the course of the reduction, the anolyte gets diluted and is withdrawn and replaced by 30 per cent. alkali whenever necessary. When 50 per cent. of the current required theoretically for the formation of hydrazotoluene had been passed, 200 cc. of xylene were added and the reduction continued, till the solvent layer was colourless. The alkali and xylene layers were withdrawn from the cell, separated and the alkali layer extracted with a further 100 cc. of xylene. Any free alkali in the combined xylene extracts was neutralized by passing carbon dioxide. The xylene layer was then poured into a mixture of 80 cc. HCl (1.16), 150 gms. ice and 2 cc. of saturated sodium bisulphite solution. The mixture was stirred for five hours in the cold and raised to gentle boiling during the sixth hour. After cooling, the mixture was filtered, and the aqueous and xylene layers separated from the filtrate. The residue, consisting mainly of toluidine hydrochloride, was dissolved in the aqueous layer from the filtrate by heating to boiling. To the clear solution, 20 cc. of con. sulphuric acid (1.835) diluted with 50 cc. of water was added. The toluidine sulphate was precipitated in a crystalline condition and was filtered after leaving overnight in the refrigerator. The filtrate from the toluidine

sulphate was basified with sodium carbonate and steam-distilled. The distillate was worked up for *ortho* toluidine. The xylene layer was also submitted to steam-distillation to remove the xylene. The residue was left exposed in an open beaker for removing traces of xylene and the azotoluene then filtered and weighed.

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References

- ¹ Dey, Govindachari and Rajagopalan, *J. Sci. Ind. Res.*, 1946, **4**, 5519.
- ² Elbs and Kopp, *Z. elek. chem.*, 1898, **5**, 110.
- ³ Haussermann, *Chem. Zeit.*, 1893, **17**, 129.
- ⁴ Lob, *Z. elek. chem.*, 1898, **5**, 459.

- ⁵ McKee and Gerapostolou, *Trans. Amer. Elec. Soc.*, 1935, **68**, 329.
- ⁶ Wulffing, *D.R.P.*, 100,233 (1898).
- ⁷ Straub, *D.R.P.*, 79,731 (1894); Darmstädter, *D.R.P.*, 181,116 (1904); Ciba, *D.R.P.*, 297,019; Bayer, *D.R.P.*, 121,899, 121,900 (1900); Brunner, *E.P.* 157,50 (1915).
- ⁸ Dieffenbach, *D.R.P.*, 197,714 (Friedlander, **9**, 112).
- ⁹ Engelhardt, *Handbuch der technischen Elektrochemie*, 1933, Band II, Teil II, 254.
- ¹⁰ Stieglitz and Curme, *Ber.*, **46**, 911; Curme, *Amer. Chem. Soc.*, 1913, **35**, 1143.
- ¹¹ Bayer, *D.R.P.*, 121,900, 121,899 (1900).
- ¹² Elbs, *Z. elek. chem.*, 1904, **10**, 579.
- ¹³ Pellegrini, *Gior. chim. ind. applicata*, 1926, **8**, 175.
- ¹⁴ Bamberger, *Ber.*, 1900, **33**, 3623.
- ¹⁵ Lob, *Z. elek. chem.*, 1904, **10**, 582.
- ¹⁶ Noelting and Werner, *Ber.*, **28**, 3253.
- ¹⁷ Ullmann, *Enzyklopaedie der technischen chemie*, **10**, 42.
- ¹⁸ Holleman, *Rec. trav. chim Pays Bas.*, 1902, **27**, 461; *Ber.* **36**, 4260.
- ¹⁹ Schöen, *Chem. Zeit.*, **12**, 494; *J. Soc. Chem. Ind.*, **7**, 594.

PART V—THE ELECTROLYTIC REDUCTION OF ORTHO NITRO ANISOLE IN ALKALINE EMULSION

IN continuation of a systematic study of the electrolytic reduction of nitro compounds in alkaline emulsion, the experiments carried out with *ortho* nitro anisole are reported here.

On the industrial scale, hydrazoanisole is generally produced by the reduction of *ortho* nitro anisole in alcoholic solution with zinc and caustic soda^{1,2,3}. It is also produced by reduction of *ortho* nitro anisole in alcohol or pyridine solution with sodium amalgam, the reduction in aqueous emulsion with this agent producing mainly anisidine⁴. The electrolytic reduction of *ortho* nitro anisole in alcoholic solution has been described by Elbs⁵, Brand⁶ and Wulffing⁷. The electrolytic reduction in sodium potassium xylene sulphonate solution has been described by McKee and Gerapostolou⁸. Apart from a few references in patent specifications, no systematic work on the electrolytic reduction of *ortho* nitro anisole in alkaline emulsion has so far been reported.

The reduction of *ortho* nitro anisole in alkaline emulsion was studied with reference to the following factors: influence of catalysts, influence of current density, influence of concentration of alkali and of depolarizer. The results are presented in the tables on next page.

From the results presented in Table I it is seen that

- (1) At an iron cathode, the reduction does not proceed to an appreciable extent beyond the azoxy anisole stage and anisidine is formed in large amounts as a by-product.
- (2) The most satisfactory catalyst is lead monoxide, leading to the highest yield of hydrazoanisole.
- (3) Zinc oxide leads to more of anisidine being formed and a marked inhibition of reduction to the hydrazo stage.
- (4) The addition of tin oxide takes the reduction to completion, there being hardly any azo or azoxy bodies found, but anisidine preponderates over the hydrazo body.
- (5) Ceric sulphate or vanadium pentoxide are of no value in increasing the yield of hydrazoanisole. In the presence of these compounds, the main products are anisidine and a mixture of azo and azoxy anisole, hydrazo formation being negligible.

Since lead oxide was indispensable for the production of the hydrazo compound in good yields, the studies detailed in Tables II-IV were conducted only with the addition of this agent. The following conclusions could be drawn from the results presented:—

TABLE I. *Influence of Catalysts*

100 gms. *ortho* nitro anisole; 400 cc. of 10 per cent. sodium hydroxide; current strength 20 amps.; apparent current density 2 amps./sq.dm.; temperature 80° C.; iron cathode.

Catalyst		Total current amp. hrs.	Dianisidine yield		Anisidine yield		Azoanisole yield	
Name	gms.		gms.	%	gms.	%	gms.	%
Nil	Nil	115	8	10	33	41.1	34*	
PbO	10	114	54	67.7	17.7	22	5	6.3
ZnO	20	125	7	8.8	38	47.3	27*	
SnO	5	137	32	40.1	45	55.9	2	2.5
V ₂ O ₅	5	123	3	3.8	47	58.5	28*	
PbO and V ₂ O ₅	10	105	50	62.7	21	26.1	5	6.3
V ₂ O ₅ Ce (SO ₄) ₂	5	121		3.8	30	37.3	47*	

* The colour of the solvent layer was not completely discharged in these cases, the products being anisidine and a mixture of azo and azoxy anisole the exact composition of the latter being not determined.

TABLE II. *Influence of Current Density*

100 gms. of *ortho* nitro anisole; 400 cc. of 10 per cent. sodium hydroxide; 10 gms. lead oxide; iron cathode; temperature 80° C.

Apparent current density amps./sq.dm.	Total current amp. hrs.	Dianisidine yield		Anisidine yield		Azoanisole yield	
		gms.	%	gms.	%	gms.	%
1	110	53	66.5	15	18.6	2	2.5
2	114	54	67.7	17.7	22	2	2.5
5 till azoxy stage and 1 after	124	53	66.5	16.3	20.3	3	3.8

TABLE III. *Influence of Concentration of Alkali.*

100 gms. *ortho* nitro anisole; 400 c.c. sodium hydroxide solution; 10 gms. lead oxide; apparent current density 2 amps./sq.dm.; iron cathode; temperature 80° C.

Strength of alkali %	Total current amp. hrs.	Dianisidine yield		Anisidine yield		Azoanisole yield	
		gms.	%	gms.	%	gms.	%
10	114	54	67.7	17.7	22.0	2	2.5
20	114	49	61.5	11.8	14.7	1	1.3
30	102	52	65.2	16.8	20.9	1	1.3
40	120	48	60.2	25.5	31.7	4	5
50	120	47	58.9	18.1	22.5	1	1.3

TABLE IV. *Influence of Concentration of Depolarizer.*

Iron cathode; 10 gms. PbO; apparent current density 2 amps./sq.dm.; temperature 80° C.

<i>Ortho</i> nitro- anisole		10% alkali cc.	Ratio*	Total current amp. hrs.	Dianisidine yield		Anisidine yield		Azoanisole yield	
gms.	cc.				gms.	%	gms.	%	gms.	%
96.8	80.7	402	1:5	98.3	47	60.9	17.5	22.5	3	2.5
118.3	98.6	394	1:4	150	74	78.4	13.5	14.3	5	5.3
147.9	123.3	370	1:3	172	81	68.2	19	15.9	2	1.7

* Ratio of depolarizer to alkali by volume.

- (1) There is no appreciable diminution in anisidine formation by operating at a lower current density.
- (2) There is no definite improvement in the yield of hydrazo-anisole by increasing the concentration of alkali above 10 per cent.

- (3) By operating with a depolarizer concentration of one to four volumes of alkali, the dianisidine is obtained in the highest yield; nearly 80 per cent. of theoretical.

As in the electrolytic reduction of *ortho* nitro toluene, the formation of amine as a

secondary product along with the hydrazo compound detracts to a certain extent from the value of this electrolytic method. The reasons for amine formation even in alkaline media have been fully discussed in Part IV of this series⁹. It does not seem possible to reduce the formation of anisidine to any considerable extent by the alteration of conditions such as current density, concentration of alkali and depolarizer and catalysts. It may be pointed out, however, that compared to the preparation of toluidine (from *ortho* nitro toluene) by the electrolytic method, the preparation of dianisidine from *ortho* nitro anisole was achieved in much higher yields. Although anisidine was formed to a somewhat smaller extent than toluidine, the larger yield of dianisidine should really be attributed to the better yields in the second stage, viz., the conversion of hydrazoanisole to dianisidine.

Since anisidine is also of value as a dye-intermediate, its production simultaneously with hydrazoanisole need not be considered as an objection to the application of the electrolytic method on a technical scale.

Experimental

Standard procedure adopted in the electrolytic reduction of ortho nitro anisole.—The studies were conducted in the small oval iron cell employed in the early studies with nitrobenzene and *ortho* nitro toluene and described in detail¹⁰.

The reduction of *ortho* nitro anisole was carried out in exactly the same way as reported under *ortho* nitro toluene. The xylene solution containing the mixture of hydrazoanisole and anisidine was, however, poured (when 100 gms. *ortho* nitro anisole had been taken) into 38 cc. of sulphuric acid (*d.* 1.835), 38 cc. water and 150 gms. ice. The mixture was stirred for five hours in the cold, raised to 60° C. and stirred for a further two hours after which the temperature was raised to 90° C. The mixture was left overnight, filtered and the residue washed with hot xylene. It is essential that only the minimum amount of water should be employed in this operation, so that the amount of dianisidine carried over into the filtrate may be restricted (Filtrate A). The residue consisting of dianisidine sulphate was dissolved in water and basified. The dianisidine was precipitated and was filtered and dried. Filtrate A consisted of two layers (water and xylene) which were separated. The aqueous layer was basified with ammo-

nia and steam-distilled to remove anisidine, which was worked up from the distillate. The residue after steam-distillation consisted of a small amount of dianisidine of a rather impure grade. The xylene layer was steam-distilled to remove xylene and the *ortho* azo anisole which was left behind was filtered and weighed.

Isolation of Hydrazoanisole.—In one reduction with 100 gms. of *ortho* nitro anisole carried out in 10 per cent. sodium hydroxide solution at 20 amps. and 80° C. and with the addition of 10 gms. of lead oxide, the products from the electrolytic cell were removed by benzene at the end of the reduction. The benzene extract was washed with water to remove alkali and then with dilute hydrochloric acid (25 cc. concentrated hydrochloric acid and 100 gms. ice) to remove the anisidine. The benzene was then removed by distillation *in vacuo*, using cold brine in the condenser. The residue was hydrazoanisole which was slightly reddish due to oxidation during isolation. On washing with methanol, colourless crystals, m.p. 102° C. were obtained. Yield, 58 gms. (72.1 per cent.). The acid solution used for washing the benzene extract, on basifying and steam-distillation gave 18.7 gms. of anisidine (22 per cent.).

Conversion of Hydrazoanisole to Dianisidine.—22 gms. of hydrazoanisole in 60 cc. of xylene were subjected to the "benzidine transformation" by treatment with 10 cc. sulphuric acid (*d.* 1.835), 10 cc. water and 50 gms. ice, stirring for five hours in the cold, for two hours at 60° C. and then at 90° C. for one hour. On working up in the usual way, 20 gms. dianisidine (90 per cent.) were obtained, m.p. 135° C.

Our grateful thanks are due to the Council of Scientific and Industrial Research, for a grant which defrayed the expenses of this investigation and for kind permission to publish the results.

References

- 1 Teichmann, *Zeit. angew. Chem.*, 1893, 6, 67.
- 2 Erdmann, *ibid.*, 163.
- 3 Groggins, *Unit Processes in Organic Synthesis*, 1935, 108.
- 4 Pellegrini, *Gior. chim. ind. applicata*, 1926, 8, 175.
- 5 Elbs, *Zeit. Elektrochem.*, 1900, 7, 146.
- 6 Brand, *J. pr.* (2), 1903, 67, 157.
- 7 Wulffing, *D.R.P.*, 100234 (1899).
- 8 McKee and Gerapostolou, *Trans. Amer. Elec. Chem. Soc.*, 1935, 68, 329.
- 9 Dey, Govindachari and Rajagopalan, *J. Sci. Ind. Res.*, 1946, 4, 637.
- 10 Dey, Govindachari and Rajagopalan, *ibid.*, 1946, 4, 559.

PART VI—THE ELECTROLYTIC REDUCTION OF *ORTHO* NITRO-CHLOROBENZENE IN ALKALINE EMULSION

3,3'-DICHLORO-4,4'-DIAMINO diphenyl, or *ortho* dichloro benzidine is an intermediate leading to the production of certain direct cotton colours¹. It was first described by Levinstein² who prepared it by chlorinating a fine suspension of diacetyl benzidine in dilute sulphuric acid and hydrolysing the dichloro diacetyl benzidine so formed with 20 per cent. hydrochloric acid. Later, Cohn³ published a procedure in which *ortho* nitrochlorobenzene was reduced in alcoholic solution with zinc and caustic soda to *ortho* dichloro hydrazobenzene, the latter being converted to *ortho* dichloro-benzidine by boiling in concentrated hydrochloric acid. No mention is made of the yield of the products obtained or the proportion of acid employed for effecting the "benzidine transformation." Lukashevich⁴ has followed a similar procedure and obtains *ortho* dichlorobenzidine in 72-74 per cent. yield from *ortho* nitrochlorobenzene.

According to Elbs⁵, *ortho* nitrochlorobenzene on electrolytic reduction in alcoholic solution gives *ortho* dichloro azoxybenzene in 45 per cent. yield, the rest being *ortho* chloraniline and *ortho* amino phenol. By further electrolytic reduction *ortho* dichloro hydrazobenzene is obtained in 70 per cent. yield from *ortho* dichloro azoxy benzene or in an overall yield of 31.5 per cent. from *ortho* nitro chlorobenzene.

The investigations reported in this paper, on the electrolytic reduction of *ortho* nitrochlorobenzene in alkaline emulsion, were taken up as a part of the systematic study of the electrolytic reduction of nitro compounds⁶. The following points have emerged as a result of studies on the reduction of nitrobenzene, *ortho* nitro toluene and *ortho* nitro anisole⁶:—

- (1) In order to obtain hydrazo compounds in good yields, lead monoxide is indispensable as a catalyst.
- (2) A depolarizer concentration of one to four volumes of sodium hydroxide solution leads to the best yield of hydrazo compound and high current efficiency.
- (3) The employment of a low current density like 1 amp./sq.dm. is favourable in improving the current efficiency and lowering amine formation to some extent.

It was, therefore, considered unnecessary to carry out further detailed studies of the influence of current density, concentration of alkali and depolarizer and of different catalysts on the electrolytic reduction of *ortho* nitrochlorobenzene, the work being restricted to such conditions as had already been found favourable in the case of other nitro compounds. The results are presented in Table I.

It will be seen that the preparation of *ortho* dichloro hydrazobenzene in nearly 85 per cent. yield is possible by employing an approximate depolarizer concentration of one to four volumes of 10 per cent. sodium hydroxide solution and operating at a current density of 1 amp./sq.dm. Under these conditions, the current efficiency also reaches a high value. The hydrazo compound is obtained in a state of high purity, melting sharply at 87° C. and is almost colourless.

The most noteworthy feature about *ortho* dichloro hydrazobenzene is its extraordinary stability in air and resistance to the "benzidine change" as compared to *ortho* hydrazo anisole or *ortho* hydrazo toluene. By employing 2.2 mols of hydrochloric acid or 1.1 moles sulphuric acid and operating under the usual conditions, *ortho* dichloro hydrazobenzene was not found to undergo the "benzidine transformation" to any appreciable extent, nearly the whole of the hydrazo compound being recovered unchanged. After a series of systematic trial experiments, success was ultimately attained in effecting the "benzidine transformation" in 91.5 per cent. yield by employing 10 moles of 50 per cent. sulphuric acid. Approximately 7 per cent. of a mixture of hydrazo and azo compounds was also recovered. The total yield in the "benzidine transformation" thus works out to 98.4 per cent. by making an allowance for the unreacted hydrazo compound.

Ortho dichloro benzidine can, therefore, be prepared in an overall yield of more than 80 per cent. by the electrolytic reduction of *ortho* nitro chlorobenzene in alkaline emulsion. The method has the further advantages of superiority of yield, purity of product and simplicity of operation over the chemical method.

TABLE I. *Iron gauze cathode; Temperature 80° C.; 10 gms. lead oxide as catalyst.*

<i>o</i> -nitrochloro- benzene gms.	Sodium hydroxide solution		Current			Dichloro hydrazobenzene		Chloraniline	
	c.c.		Total amp.hrs.	Strength amps.	Density amp./ sq.dm.	Effi- ciency* %	gms.	%	gms. %
100.0	400	10	110	20	2	59.0	61	76.0	6.0
100.0	400	30	127	20	2	53.5	64	79.7	9.0
128.8	387	10	128	10	1	72.2	87	84.1	7.4

* Current efficiency calculated with regard to dichloro hydrazobenzene.

Experimental

The reductions were conducted in the small oval iron cell described earlier in this series, under precisely the same conditions as those used in the cases of nitrobenzene and *ortho* nitro toluene⁶. When 90 per cent. of the theoretically required current had been passed, the temperature of the cell was brought to 75° C. and 200 c.c. of benzene was added. The reduction was continued till the benzene layer was colourless. The contents of the cathode chamber were then drawn out and the latter rinsed with a further 150 c.c. of benzene. The benzene layer was then separated and washed with water to free it from alkali. It was then shaken with 20 c.c. of hydrochloric acid (*d* 1.16) diluted with 200 c.c. water, in several portions. The hydrochloric acid removed the chloraniline, which was later worked up from the acid solution by basification and steam-distillation. The benzene layer was washed free from acid, and the benzene removed under reduced pressure over a water bath, using cold brine in the condenser. The residue was dried to constant weight in a vacuum desiccator. This was *ortho* dichloro hydrazobenzene and was coloured only a very slight red; m.p. 87° C. On washing with methanol, perfectly colourless crystals were obtained, which remained colourless even after exposure to air for several days.

Conversion of ortho dichloro hydrazobenzene to ortho dichloro benzidine.—50 gms. of the finely powdered hydrazo compound were added to a mixture of 113.5 c.c. of sulphuric acid (*d* 1.835) and 180 c.c. water. At the commencement of the addition, the temperature was maintained at 10° C. and the mixture was allowed to rise to room temperature during five hours of stirring. The temperature was then raised to 50° C.

and the stirring continued for a further five hours. 150 c.c. of xylene were then added and the temperature raised to 90° C. during one hour and then allowed to cool overnight.

The major portion of the dichloro benzidine sulphate crystallized out and was filtered. The residue was repeatedly washed with small portions of hot xylene totalling 100 c.c. to remove traces of adhering azo compound. (Filtrate A.) The residue was then dissolved in nearly 2 litres of boiling water, acidified with a small amount of dilute sulphuric acid (50 c.c., 4 N). The clear solution of the sulphate was treated at the boiling temperature with a saturated solution of sodium carbonate till just alkaline. The precipitated dichlorobenzidine was filtered after cooling. Yield 43 gms., m.p. 132-33° C.

Filtrate A consisted of two layers (water and xylene) which were separated. The aqueous layer on basification gave 2.75 gms. of dichloro benzidine. The xylene layer was steam-distilled to remove xylene and the residue filtered and dried. This was apparently a mixture of unconverted hydrazo compound mixed up with azo compound formed by oxidation. Yield 3.5 gms., m.p. 85-120° C.

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References

- Schultz, *Farbstoff Tabellen*, Nos. 356, 357, 358.
- Levinstein, *D.R.P.* 94410; *C.Z.*, 1898, 1, 295; *D.R.P.* 97101; *C.Z.*, 1898, 2, 522.
- Cohn, *Ber.*, 1900, 38, 3551.
- Lukashevich, *Anilinkrasnochaya, Prom.*, 1934, 4, 605.
- Elbs, *Zeit. Elektrochem.*, 1900, 7, 137.
- Dey, Govindachari and Rajagopalan, *J. Sci. Ind. Res.*, 1946, 4, 559.

STUDIES ON INDUSTRIAL MICRO-ORGANISMS

PART III—VITAMIN REQUIREMENTS OF SOME STRAINS OF YEAST

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Introduction

WILDIERS¹ found that fermentation of yeast in a medium composed of inorganic salts and sugar could take place only in the presence of either a considerable quantity of the inoculum, or on addition of a new substance present in sterile yeast water which he called "bios"; this discovery was followed by a series of investigations on the nutritive and growth-promoting factor requirements of yeast².

Subsequent work on "bios" related mainly to an elucidation of its multiple nature and to the separation of the active principles³⁻¹⁵. The possible relation of bios to vitamins was indicated simultaneously by Williams¹⁶ and Bachmann¹⁷. In 1928 Eastcott⁶ isolated Bios I, stimulatory to the growth of certain strains of yeast from tea dust and established its identity with inositol. Later, yeast growth promoting properties of other compounds were demonstrated: Thiamin by Williams and Rothen¹⁸; pantothen by Williams and co-workers¹⁹; biotin by Kögl and Tönnis²⁰; pyridoxin by Schultz, Atkin and Frey,³² and niacin and nicotinamide by Koser, Wright and Dorfman²¹ and by Rogosa²². Recent workers have studied more extensively the relationship of various members of the B-complex to the growth of yeast. Williams and Saunders²³ have shown the effect of inositol, thiamin and pantothen on the growth of different strains of yeast; Williams, Ealim and Snell²⁴ the relationship of thiamin, biotin, pantothen and pyridoxin to the growth of three different strains of yeast. Schultz, Atkin and Frey²⁵ have suggested a biochemical classification of yeast, which is based on the response of 44 strains to thiamin and pyridoxin. Lockhead and Landerkin²⁶ have studied 23 strains of osmophilic yeasts of the genus *Zygosaccharomyces* with respect to their requirements of inositol, biotin, pantothen, thiamin and pyridoxin, and Koser and Wright²⁸ the vitamin requirements of *Torula cremoris*. Leonian and Lilly²⁷ have studied the thiamin, pyridoxin, inositol and pantothen requirements of ten strains of *Saccharomyces cerevisiae*. Rogosa²⁹ has made a comparative

study of the inositol, thiamin, pantothen, biotin, niacin, nicotinamide, choline, riboflavin and folic acid requirements of some strains of lactose-fermenting yeasts and *S. cerevisiae*, and Børkholder, McVeigh and Møyr³⁰ the biotin, thiamin, pantothen, inositol, niacin, pyridoxin and riboflavin requirements of 163 strains of yeasts.

The present communication deals with the vitamin B-complex requirements of 17 strains of yeasts maintained in the *National Collection of Type Cultures, India*.

Experimental

A. *Basal Medium*.—The following stock solutions were prepared:

1. Glucose (Mercks) solution, 40 gm. in 100 c.c.
2. Salt solution, one litre contained 4.4 gm. KH_2PO_4 ; 3.4 gm. KCl ; 1.0 gm. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$; 1.0 gm. $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$; 20 mgm. each of FeCl_3 and MnSO_4 ; 8 mgm. each of TiCl_3 , H_3BO_3 and ZnSO_4 ; and 0.8 gm. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.
3. Citric acid-potassium citrate buffer of pH 4.6.
4. Ammonium sulphate solution, 15 gm. in 100 c.c.
5. Inositol solution, 1 mgm./c.c.
6. *l*-aspartic acid solution, 400 mgm. in 100 c.c.
7. A solution of a mixture of nucleic acids, 490 $\mu\text{gm}/\text{c.c.}$

Experimental solution: (Basal medium with inositol) was made up as follows employing the above stock solutions:—

25 c.c. glucose, 25 c.c. salt solution, 10 c.c. buffer, 5 c.c. ammonium sulphate, 5 c.c. *l*-aspartic acid, 2 c.c. nucleic acid and 1 c.c. inositol, all of which was made up to 100 c.c. with distilled water. Basal medium without inositol¹⁶ was also prepared in a similar way. To prevent caramelisation, the media were sterilized by steaming every

24 hours for three days for half an hour each time.

B. Vitamin solutions: (1) The "all vitamins" solution contained per c.c., 1 μ gm. each of thiamin, pyridoxin, riboflavin pantothen, *p*-aminobenzoic acid and niacin, 1.5 μ gm. of biotin (S.M.A.C.O. free acid), 25 μ gm. tryptophane and 1.2 mgm. of casein hydrolysate were also added to the mixture. (2) Mixtures of vitamin solutions as above but omitting one of the B-complex vitamins at a time, were also prepared. (3) Standard choline chloride solution contained 2 μ gm. choline chloride/c.c. These solutions were kept under toluene.

Method: Instead of bacteriological tubes, 50 c.c. Erlenmeyer flasks were used for the experiments. Each flask contained 2.5 c.c. basal medium, 2 c.c. vitamin solution, 1 c.c. water (or choline-chloride solution) and 0.5 c.c. inoculum, making a total volume of 6 c.c.

After adding the addenda, the flasks were steamed for 15 minutes, cooled and inoculated.

Inoculum: The inoculum was prepared from a 24 hours culture of the yeast previously grown on wort-agar slants, at 30° C. A suspension of the yeast cells was made in isotonic saline, adjusting the density to 0.4 mgm./0.5 c.c. by referring to a standard giving the relationship of mgm. moist yeast to galvanometer deflection.

The flasks were incubated at 30° C. for 18 hours and the turbidity measurements taken by means of a photo-electric turbido-

meter in cuvettes of 11 c.c. capacity, by making up the volume in each flask with water. The results are given in Table I.

Discussion

The data show that pantothen, biotin and inositol are the critical factors for the growth of most of the yeasts tested. Pantothen is essential for the growth of 14 strains and unnecessary for 3. With the exception of one yeast in the case of biotin and two strains in the case of inositol, all the strains are dependent for optimal growth on these two B-Complex vitamins to a greater or lesser extent. Pyridoxin is necessary for the growth of all but two strains, but essential for none. Riboflavin has a slightly stimulating effect on the growth of some yeasts, niacin on *S. ellipsoideus* No. 3021 and the *torula* yeasts Nos. 3011, and 3050, and choline on *S. ellipsoideus* No. 3043. This last factor has a slightly adverse effect on the growth of *Torula utilis* No. 3050 and *S. cerevisæ* No. 3008. Thiamin is a critical factor for only three yeasts, but necessary for the growth of almost all the other strains.

Rogosa²⁹ emphasized the importance of a short period of incubation in studying the vitamin requirements of yeasts. He showed that during a long period of incubation, yeasts may synthesize the vitamin in which the medium is deficient. This fact was also observed by us in some early experiments on the suitability of various yeasts belonging to the *National Collection of Type Cultures* for the microbiological assay of pyridoxin. Table II gives the results obtained in the case of two yeasts.

TABLE I. Absorption in Galvanometer Readings

Yeasts	Basal	All Vitamins	Lacking Thiamin	Lacking Pantothen	Lacking biotin	Lacking inositol	Lacking pyridoxin	Lacking riboflavin	Lacking niacin	Lacking <i>p</i> -amino benzoic acid	medium all vitamins + choline
1. <i>S. carlsbergensis</i> No. 3056	2.5	22.5	23.5	8.0	8.3	17.0	16.5	21.5	22.0	22.0	23.0
2. <i>S. cerevisæ</i> No. 3004	2.0	37.0	25.0	4.0	5.0	6.0	18.0	33.0	38.0	37.0	38.0
3. " No. 3006	2.5	36.0	5.8	3.0	6.5	7.5	24.0	32.0	36.0	36.0	35.5
4. " No. 3007	2.0	40.0	31.0	5.0	9.0	8.0	20.0	35.0	40.0	39.5	38.0
5. " No. 3008	1.5	37.0	27.0	7.8	6.0	9.0	17.0	36.5	37.0	37.0	32.5
6. " No. 3041	3.0	38.0	33.0	5.0	8.8	17.8	23.0	37.0	38.0	38.0	38.8
7. " No. 3052	3.5	38.0	36.0	6.0	16.0	25.0	31.0	38.0	38.0	38.0	39.0
8. <i>S. Ellipsoideus</i> No. 3021	2.5	33.0	26.0	5.0	5.0	9.0	14.0	31.0	26.0	33.0	33.0
9. " No. 3042	0.5	26.5	21.0	2.0	8.0	14.0	11.0	27.0	27.0	26.5	26.0
10. " No. 3043	0.0	26.0	18.0	4.0	7.0	0.0	21.5	26.0	25.0	25.0	30.5
11. " No. 3045	1.0	37.0	28.0	16.0	34.0	25.0	29.0	36.0	35.0	36.0	37.5
12. <i>Torula utilis</i> No. 3011	2.5	39.0	34.0	19.0	31.0	30.0	30.0	39.0	39.5	36.8	39.0
13. " No. 3011	3.0	34.0	30.0	5.0	12.0	21.0	23.0	31.5	32.5	33.0	32.0
14. " No. 3050	1.0	30.0	7.5	30.0	27.0	30.0	30.0	30.0	26.0	29.0	27.0
15. Distillery yeast No.	9.5	38.0	35.0	21.0	25.0	29.0	33.0	38.0	38.0	38.0	39.0
16. Yeast isolated from butter	1.5	20.0	5.5	20.8	6.0	19.0	10.0	20.0	19.5	20.0	20.5
17. " " " coffee	5.0	7.0	7.0	7.0	5.0	7.0	7.0	7.0	6.0	7.0	7.0

TABLE II.

Yeast	24 hrs. Incubation		48 hrs. Incubation	
	Without B ₆	With B ₆	Without B ₆	With B ₆
<i>S. cerevisiae</i> No. 3041	3	20	47.5	51
<i>S. cerevisiae</i> No. Y 29	6	20	48.5	51

It may be seen, therefore, that the period of incubation is a factor important enough to be taken into consideration while studying the suitability of a particular yeast for the assay of a vitamin.

A biochemical classification of strains of *S. cerevisiae* has been suggested by Rainbow¹⁵, Schultz, Atkin and Frey²⁵ and of osmophilic yeasts by Lockhead and Landerkin.²⁶ The results obtained above suggest that the *Torula* and distillery yeasts are generally more autotrophic with respect to the B-complex vitamins than either *S. cerevisiae* or *S. ellipsoideus*.

Summary

1. The thiamin, pantothen, biotin, inositol, pyridoxin, riboflavin, niacin, *p*-aminobenzoic acid and choline requirements of 17 strains of yeasts belonging to the *National Collection of Type Cultures*, have been studied.

2. The period of incubation is an important factor in the study of the nutritive requirements of yeasts.

3. *Torula* and distillery yeasts appear to be more autotrophic with respect to the vitamins of the B-complex than *S. cerevisiae* and *S. ellipsoideus*.

4. On increasing the concentration of casein hydrolysate to an optimal value for the yeast, *S. cerevisiae* 3004, an experimental medium, suitable for microbiological assays has been obtained.

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References

- Wildiers, E., *La Cellule*, 1901, **18**, 313.
- Williams, R. J., *Biol. Rev.*, 1941, **16**, 49.
- Eddy, W. H., Kher, R., Williams R. R., *J. Amer. Chem. Soc.*, 1924, **46**, 2846.
- Fulmer, E. J., Duecker, W. W., Nelson, V. E., *Ibid.*, 1924, **46**, 723.
- Tanner, F. W., *Chem. Rev.*, 1925, **1**, 397.
- Williams, R. J., Wilson G. L., Von Der Ahe, F. H., *J. Amer. Chem. Soc.*, 1927, **49**, 227.
- Eastcott, E. V., *J. Phys. Chem.*, 1928, **32**, 1094.
- Miller, W. L., *J. Chem. Education*, 1930, **7**, 257.
- (a) Miller, W. L., Eastcott, E. V., Sparling, E. M., *Trans. Roy. Soc. Can.*, 1932, **26**, III, 165.
(b) Miller, W. L., *Ibid*, 1934, **28**, III, 185.
(c) Miller, W. L., *Ibid*, 1935, **29**, III, 163.
(d) Miller, W. L., *Ibid*, 1936, **30**, III, 99.
(e) Miller, W. L., *Ibid*, 1937, **31**, III, 159.
(f) Miller, W. L., *Proc. Third International Congress Microbiol.*, 1939, 498.
- Williams, R. J. and Bradway, E., *J. Amer. Chem. Soc.*, 1931, **53**, 783.
- Peshett, G. L., *Biol. Rev.* 1933, **8**, 1.
- Farrel, L. N., *Trans. Roy. Soc., Can.*, 1935, **29**, III, 167.
- Lesh, J. B., Underkoffler, L. A., Fulmer, E. I., *J. Amer. Chem. Soc.*, 1938, **60**, 2505.
- Oledti, N., *J. Agri. Chem. Soc. Japan*, 1938, **14**, 1479.
- Rainbow, C., *J. Inst. Brewing*, 1939, **45**, 533.
- Williams, R. J., *J. Biol. Chem.*, 1919, **38**, 465.
- Bachmann, F. M., *Ibid.*, 1919, **39**, 235.
- Williams, R. J., Roehm, R. R., *Ibid.*, 1930, **87**, 581.
- Williams, R. J., Lyman, C. M., Holaday, D., *J. Amer. Chem. Soc.*, 1933, **55**, 2912.
- Kogl, F., Tönnis, B., *Z. Physiol. Chem.*, 1936, **242**, 43.
- Koser, S. A., Wright M. H., Dorfman, A., *Proc. Soc. Expl. Biol. Med.*, 1942, **51**, 204.
- Rogosa, M., *J. Bact.*, 1943, **46**, 435.
- Williams, R. J., Saunders D. H., *Biochem. J.*, 1934, **28**, 1887.
- Williams, R. J., Eakin, R. E., Snell, E. E., *J. Amer. Chem. Soc.*, 1940, **62**, 1204.
- Schultz, A. S., Atkin, L., Frey, C. N., *J. Bact.*, 1940, **40**, 339.
- Lockhead, A. G., Landerkin, G. B., *Ibid.*, 1942, **44**, 343.
- Leonian, L. H., Lilly, V. G., *Amer. J. Bot.* 1942, **29**, 459.
- Koser, S. A., Wright, M. H., *Proc. Soc. Expl. Biol. Med.*, 1943, **53**, 249.
- Rogosa, M., *J. Bact.*, 1944, **47**, 159.
- Burkholder, P., Moyer, D., McVeigh, I., *Ibid.*, 1944, **48**, 385.
- Schultz, A. S., Williams, W. L., Atkin, L., Frey, C. N., *Ind. Eng. Chem., Anal. Edn.*, 1944, **16**, 67.
- Schultz, A. S., Atkin, L., Frey, C. N., *J. Amer. Chem. Soc.*, 1939, **61**, 1931.

EFFECT OF THIAMIN, NIACIN AND RIBOFLAVIN ON THE GROWTH OF YEAST

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WILDIERS¹ showed that some organic substances, which he called "Bios," when present in the medium stimulated the growth of yeast. Later investigations on "bios" requirements of yeasts indicated that the type of yeast and the composition of the medium were of importance. (Earlier work on "bios" has been reviewed by Tanner^{2,3}.) "Bios" has been shown to be composed of a number of growth factors which have been fractionally separated. Inositol (Eastcott⁴); thiamin and pantothenic acid (Williams, *et al.*^{5, 6}); β -alanine and leucine (Miller⁷), and biotin (Kögl and Tönnis^{8, 9}) have been identified as "bios" components. The important contributions to this subject have been reviewed by Miller and co-workers¹⁰⁻¹⁵ and Williams¹⁶. A review on the nutritive requirements of osmophilic yeasts has been published by Lockhead and Landerkin¹⁷.

The components so far isolated from "bios" are factors belonging to the vitamin B complex. It was of interest to ascertain whether riboflavin and niacin, which are not generally associated with "bios" had any stimulating effect upon the growth of yeast.

Williams¹⁸ observed that small amounts of thiamin stimulated the growth of yeasts. Schultz, Atkin and Frey^{19, 20} found that only some strains of *Saccharomyces cerevisiae* were stimulated while others were inhibited. Based on their study of 40 cultures, Schultz, *et al.* classified yeasts into 3 groups according to growth behaviour; thiamin stimulated the growth of yeasts belonging to one group, inhibited that of yeasts in the second, while it had no effect on the group of yeasts belonging to the third group.

Burkholder and co-workers²¹ observed that out of 163 different strains of yeasts studied by them, 33 were deficient in thiamin, 13 in niacin and none in riboflavin. The niacin requirements of yeasts have been studied by Rogosa^{22, 23}, who observed that only those yeasts which fermented lactose required an exogenous source of niacin. These investigations were more or less of a qualitative character.

The results of a quantitative study of varying concentrations of thiamin, riboflavin and niacin on the growth of four different cultures of yeasts are reported in this paper.

Experimental

The four strains studied are designated as follows:—

A 0	..	..	<i>S. cerevisiae</i>
A 1	..	..	<i>T. utilis</i>
A 2	..	..	<i>T. utilis</i>
A 4	..	..	<i>S. cerevisiae</i>

Basal medium.—The medium was made up of

	gms.
Glucose	70.00
Magnesium sulphate	2.00
Potassium dihydrogen phosphate	2.25
Ammonium sulphate	2.25
Calcium chloride	0.40
Ferrous sulphate	0.10
Copper sulphate	traces

The above salts were dissolved in distilled water, pH. adjusted to 4.6 and the solution made up to 1,000 c.c. The medium was sterilized by steaming for half an hour on three consecutive days.

Vitamin solutions.—Standard solutions of thiamin hydrochloride, niacin and riboflavin containing 1 μ gm. of the vitamin per c.c. were prepared in the basal medium.

Yeast inoculum.—Pure cultures of the strains were grown for a large number of generations in the laboratory on the basal medium. 1 c.c. of the culture diluted with the medium to give an initial cell count of 4-5 cells per 40 squares of hemacytometer was used as the inoculum.

Measurement Yeast Growth.—The growth was measured by counting the number of cells with the help of a hemacytometer. A cell count per 80 squares of the hemacytometer was recorded and taken as the measure of the growth of yeast. In some experiments the dry weight of yeast produced was also determined.

Procedure.—0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 2.0, 4.0, 6.0 and 8.0 c.c. of the standard

solution of the vitamin were pipetted into sterile rimless test tubes. The solutions were diluted to 9.0 c.c. with the basal medium and inoculated with 1 c.c. of the yeast suspension. The final concentration of the vitamin in the tubes was thus 0.01, 0.02, 0.04, 0.06, 0.08, 0.10, 0.20, 0.40, 0.60 and 0.80 $\mu\text{gm. per c.c.}$ respectively. The tubes were incubated at 30° C. for 48 hours after which the growth of the yeast was measured by the cell count method. All experiments were conducted in duplicate. The average of two observations was taken as the correct yeast count. Duplicate observations generally agreed closely.

The results of experiments using thiamin hydrochloride, niacin and riboflavin are summarized in Tables I, II and III respectively.

TABLE I. *Effect of Thiamin on Yeast Growth.*

Vitamin concentration $\mu\text{gm./c.c.}$	Cell counts per 80 squares for			
	A0	A1	A2	A3
0.000	75	35	41	65
0.015	93	46	47	83
0.030	110	54	54	89
0.045	125	65	63	99
0.060	134	76	68	85
0.075	150	89	85	75
0.090	135	97	96	70
0.105	119	105	97	61
0.150	107	129	107	55
0.300	98	163	99	46

TABLE II. *Effect of Niacin on Yeast Growth.*

Vitamin concentration $\mu\text{gm./c.c.}$	Cell counts per 80 squares for			
	A0	A1	A2	A3
0.01	96	125	65	61
0.02	109	154	81	93
0.04	121	151	95	121
0.06	140	131	79	107
0.08	149	108	67	95
0.10	159	83	59	82
0.20	131	65	49	69
0.40	101	52	40	52
0.60	70	41	31	46
0.80	41	33	26	39

TABLE III. *Effect of Riboflavin on Yeast Growth.*

Vitamin concentration $\mu\text{gm./c.c.}$	Cell counts per 80 squares for			
	A0	A1	A2	A3
0.01	51	95	46	78
0.02	69	113	66	96
0.04	85	126	78	75
0.06	101	145	94	69
0.08	113	106	82	59
0.10	129	95	68	51
0.20	116	82	57	43
0.40	105	73	42	30
0.60	90	61	37	21
0.80	71	49	26	16

Results

The results given in Table I reveal that the growth of yeasts is stimulated by thiamin up to a certain limit beyond which the growth is inhibited. Upto a certain range of concentration, the stimulation is directly proportional to the concentration of thiamin. The optimal requirements of thiamin for different yeasts are different. For yeasts A0, A2, and A3 they are respectively, 0.075, 0.15 and 0.045, $\mu\text{gm. per c.c.}$ A1 requires a higher concentration, and by another experiment it has been established that the optimum concentration is 4.0 $\mu\text{gm. per c.c.}$ This culture is ideally suited for the microbiological assay of thiamin by the yeast growth method (Vohra, Dhammi and Ahmad²⁴).

That large concentrations of thiamin in the medium decrease the yields of yeast has been observed by Van Laneth, *et al.*²⁵ who report also that the vitamin B₁ content of yeast can be enhanced at the cost of yield.

The growth of yeasts is stimulated by both niacin and riboflavin to a limited extent. The optimum concentrations of niacin for A0, A1, A2, and A3 are respectively 0.1, 0.02, 0.04, 0.04 $\mu\text{gm. per c.c.}$ and of riboflavin, 0.10, 0.06, 0.06 and 0.02 $\mu\text{gm. per cc.}$

Effect of Thiamin on Yeast Growth in the Presence of Optimal Concentrations of Niacin and Riboflavin.—This study was important for developing a satisfactory yeast growth method for thiamin estimation. The experimental procedure was similar to that described above, except that the basal medium contained niacin and riboflavin in the pre-determined optimum concentrations.

The growth was determined both by the cell count and dry weight estimation. For dry weight determination, a known weight of yeast inoculum was added to 20 c.c. of the medium and incubated at 30° C. for 48 hours. The yeast was separated by centrifuging, washed once with water, dried and weighed. The results are shown in Tables IV and V.

TABLE IV. *Cell Count Method.*

Thiamin concentration $\mu\text{gm./c.c.}$	Cell counts per 80 squares for			
	A0	A1	A2	A3
0.000	159	135	170	160
0.015	184	157	210	185
0.030	201	189	251	213
0.045	229	217	301	271
0.060	252	239	345	252
0.075	215	279	415	225
0.090	191	301	371	207
0.105	163	325	304	191

TABLE V. Dry Weight Method.

Yield in mgms. after correcting for yeast in inoculum.

Thiamin concentration $\mu\text{gm./cc.}$	A0	A1	A2	A3
0.00	59.68	78.94	59.26	55.04
0.06	69.28	85.94	75.26	66.84
0.12	56.08	113.14	80.86	61.44
0.18	49.48	125.34	67.06	52.64

It is interesting to observe that when niacin and riboflavin are present in optimum concentrations, the growth of yeast is greatly enhanced, the number of cells produced being nearly ten times that recorded in the previous experiments. The stimulation in growth due to thiamin is quite independent of the stimulation by niacin and riboflavin and the optimum concentrations of thiamin for growth are but slightly affected. The values are 0.06, 0.075, and 0.04 $\mu\text{g n.}$ per c.c. respectively, as compared with 0.075, 0.015, and 0.045 $\mu\text{gm./c.c.}$ in the absence of niacin and riboflavin.

Conclusions

The growth of all the four strains of yeast studied is stimulated by low concentrations of thiamin, niacin and riboflavin. There is an optimum concentration for each vitamin after which there is a marked inhibition. When optimal concentrations of niacin and riboflavin are provided in the medium, thiamin greatly stimulates yeast growth, the rate of growth being ten times that in the controls. The optimal concentrations of thiamin for the different strains are not, however, greatly affected.

Further work on the effect of niacin on yeast growth, in the presence of optimal concentrations of thiamin and riboflavin, and of riboflavin in the presence of optimal concentrations of thiamin and niacin is in progress. The effect of other "bios" factors on the growth of yeasts and their influence

on the biosynthesis of vitamins is also being studied.

The authors are thankful to the Council of Scientific and Industrial Research for financial aid for carrying out the work reported in this paper.

References

- 1 Wildiers, E., *La Cellule.*, 1901, **18**, 313.
- 2 Tanner, F. W., *Chem. Rev.*, 1925, **1**, 397.
- 3 Tanner, F. W., *The Newer Knowledge of Bacteriology and Immunology*, University of Chicago, 1928.
- 4 Eastcott, E. V., *J. Physiol. Chem.*, 1928, **32**, 1094.
- 5 Williams, R. J., and Bradway, E., *J. Am. Chem. Soc.*, 1931, **53**, 783.
- 6 Williams, R. J., Lyman, H., Goodyear, G., Tuesdail, J., and Holaday, B., *J. Am. Chem. Soc.*, 1933, **55**, 2912.
- 7 Miller, W. L., *Trans. Roy. Soc. Can.*, 1936, **30**, 99.
- 8 Kögl, F., and Tönnis, B., *Z. Physiol. Chem.*, 1936, **242**, 43.
- 9 Kögl, F., and Tönnis, B., *Chem. and Ind.*, 1938, **57**, 49.
- 10 Miller, W. L., *J. Chem. Ed.*, 1930, **7**, 257.
- 11 Miller, W. L., Eastcott, E. V., and Sparling, F. M., *Trans. Roy. Soc. Can.* 1932, **26**, 165.
- 12 Miller, W. L., *Trans. Roy. Soc. Can.*, 1934, **28**, 185.
- 13 Miller, W. L., *Trans. Roy. Soc. Can.*, 1935, **29**, 163.
- 14 Miller, W. L., *Trans. Roy. Soc. Can.*, 1937 **31**, 159.
- 15 Miller, W. L., *Rept. Proc. 3rd Int. Cong., Microbiol.*, 1939, 498.
- 16 Williams, R. J., *Biol. Rev.*, 1941, **16**, 49.
- 17 Lockhead, A. G., and Landerkin, G. B., *J. Bact.*, 1942, **44**, 343.
- 18 Williams, R. J. and Saunders, D. H., *Biochem. J.*, 1934, **28**, 1887.
- 19 Schultz, A. S., Atkin, L., and Frey, C. N., *J. Am. Chem. Soc.*, 1938, **60**, 490.
- 20 Schultz, A. S., Atkin, L., and Frey, C. N., *J. Bact.*, 1940, **40**, 339.
- 21 Burkholder, P. R., McVeigh, I., and Moyer, D., *J. Bact.*, 1944, **48**, 385.
- 22 Rogosa, M., *J. Bact.*, 1943, **46**, 435.
- 23 Rogosa, M., *J. Bact.*, 1944, **47**, 159.
- 24 Vohra, P. N., Dhammi, K. L., and Ahmad, B., *J. Sci. Ind. Res.*, 1946, **4**, 582.
- 25 Van. Laneth, J. M., Broquist, H. P., Johnson, M. J., Baldwin, I. I., and Peterson, W. H., *Ind. & Eng. Chem.*, 1942, **34**, 1294.

Letters to the Editor

MANUFACTURE OF ABIETIC ACID FROM INDIAN ROSIN

ORDINARY rosin is by far one of the most important and abundant natural resins of commerce in India, but it has not received as much scientific study as its importance in industry demands. Systematic work has been undertaken in these laboratories with a view to elucidating the chemical nature of Indian rosin and evolving better industrial uses for it.

The work on the chemistry of rosin dates back to 1826 when Baupé¹ first showed that it contained crystallizable acids. A large amount of work has since been published on the rosin acids and on their relation to the original composition of rosin. As a result, it has been established that rosin acids belong to two different groups: (a) the abietic acid group and (b) the pimaric acid group, depending upon the species of pine from which the rosin is obtained. Rau and Simonsen² have established the nature of the chief acid present in Indian rosin derived from *Pinus longifolia* and have shown it to be abietic acid of empirical formula $C_{19}H_{29}COOH$.

In an attempt to find out a more economical method for the manufacture of abietic acid from Indian rosin than is possible by any of the existing methods, e.g., acetic acid method³, high vacuum distillation method⁴, crystalline acid salt method⁵, rosin was subjected to treatment with high temperature steam. There are isolated references⁶ to this method for the preparation of abietic acid but they have not been carried to completion anywhere. Moreover, no work on the above lines has been done with Indian rosin. An apparatus was fabricated in which rosin could be treated continuously with high temperature steam at the desired temperature.

Indian rosin from *Pinus longifolia* from Jallo rosin and Turpentine Factory, Lahore, ($[\alpha]_D^{22} -6.25^\circ$ in alcohol) was subjected to this treatment for definite periods of time. It was noted that upto a temperature of about $200^\circ C$. only a little oily liquid (probably terpenes) distils over. This constitutes about 2.5 per cent. of the total rosin

treated. The steam-treated rosins thus obtained were pale in colour and crystals of abietic acid separated out easily from 90 per cent. ethyl alcohol solution, (yield 40 per cent., m.p. $148-50^\circ C$.; $[\alpha]_D^{24} -40.38^\circ$ in alcohol).

It was further observed that on progressively raising the temperature of the steam above $200^\circ C$. a yellow solid product began to distil over. The quantity of distillate increased with temperature until a temperature of about $300^\circ C$. was reached, when there was a tendency for the major portion of the rosin to distil over. On exhaustive distillation about 60 per cent. of yellow transparent solid material was obtained. During the first stages the product was bright yellow in colour with a soft consistency, which changed to a paler colour and harder consistency with the progress of distillation. The yellow product was found to be practically pure abietic acid which crystallized from dilute alcohol in rectangular plates.

In a series of experiments at different temperatures it was observed that the rosin treated at lower temperature, which yield no distillate, crystallized more easily than those treated at higher temperatures yielding yellow distillate.

Optimum conditions are being studied for the preparation of abietic acid by these two methods. These processes when developed will make cheap abietic acid available in India for organic synthesis and also for the manufacture of synthetic resins. Further work is in progress.

The authors wish to record their grateful thanks to Dr. S. Siddiqui for valuable suggestions and for his keen interest in this work.

Council of Scientific and
Industrial Research,
Delhi, 7th December 1945.

N. GHATAK.
S. P. MITRA.

¹ Ann. Chim. phys. 1826, 108.

² Indian Forest Records, 1924, 11, Part 6.

³ Steele, J. Am. Chem. Soc., 1922, 44, 1333.

⁴ Ruzicka and Meyer, Helv. Chim. Acta., 1922, 5, 315.

⁵ Dupont, Desalbres & Bernette, Bull. Inst. du Pin, 1926, No. 22, 349.

⁶ Esterfield and Bagley, J. Chem. Soc., 1904, 85, 1238.

RUBBER FROM *CRYPTOSTEGIA GRANDIFLORA*

WITH the end of war, the importance of *Cryptostegia grandiflora* as a source of rubber has declined. In view of the poor rubber content of the plant, viz., 0.3–0.5 per cent. in the twigs, and upto about 5 per cent. in the leaves (dry weight basis), the mechanical and physico-chemical methods worked out here and abroad to extract rubber from it are hardly likely to create interest in its industrial exploitation. In America, however, the process for extracting rubber from shoot clippings¹, consisting of cooking in alkali or ensiling, screening, pebble milling and flotation, is claimed to be economically feasible. A similar process was independently worked out in the laboratories of the *Council of Scientific and Industrial Research, Delhi*, the details of which have been published^{2,3}. This method, protected by Indian patent No. 32352 (1945), consists in cooking the partially dry, chopped twigs in about 1 per cent. caustic soda solution, keeping overnight, washing, adjusting the pH. to 9.5–10.0, ball-milling and flotation.

An American process⁴ for the recovery of leaf rubber consists of fermentation followed by chemical extraction. A much simpler method has been developed in these laboratories for treating leaves. It consists in grinding partially dry leaves with water containing an anti-oxidant and a surface activator, followed by flotation. The yields are almost quantitative. A patent for the process has been applied for.

Council of Scientific and Industrial Research,
Delhi, 13th February 1946. S. S. BHATNAGAR.
KARIMULLAH.
UMA SHANKER,

¹ P. J. Faulks and J. McGavack, *The Rubber Age* (N.Y.), 1945, 57, 57.

² S. S. Bhatnagar, Karimullah and Umashanker, *J. Sci. Ind. Res.*, 1944, 3, 263.

³ *Ibid.* 1945, 3, 441.

⁴ S. R. Hoover, T. J. Dietz, J. Naghski and J. W. White, Jr., *J. Ind. Eng. Chem.*, 1945, 37, 803.

EXTRACTS OF ETIOLATED SEEDLINGS OF PULSES AS SOURCES OF NITROGEN FOR DIASTASE FORMATION

THE influence of the nature and complexity of nitrogen in diastase-formation has already been indicated, and the comparative enzyme-forming capacities of some

nitrogen compounds have been shown¹. The work has now been extended to a study of the enzyme-forming capacities of other sources of nitrogen, particularly those present in the extracts of etiolated seedlings of pulses which have been shown to be rich sources of asparagine².

The extract from the seedlings is prepared as described earlier². *Aspergillus oryza* N.C.T.C.7., was employed throughout the studies. The fungus was grown on a known area of filter-paper (area 64 sq. cm.), placed in a test-tube (150 mm. × 16 mm.) and moistened with the nutrient solutions (pulse extracts, starch, salts, etc.) adopting the technique described earlier³. Experiments were conducted at two levels of nitrogen, 1 mg. and 2 mg. After inoculation, the tubes were incubated at 28° C. for 4 days; the fungus felt and the filter-paper were afterwards disintegrated, treated with water, saturated with toluene (5 c.c.), allowed to autolyse for 24 hours at 37° C. The brei is then filtered by suction, residue washed, and the washings and filtrates made up to 100 c.c. The activity of each extract was determined as described before⁴. The results are given below.

TABLE I. Total activity of enzyme-extracts.

	Bran	Green gram	Black gram	Bengal gram	Horse gram
4th Day*					
1 mg. N.	144.7	247.8	251.0	331.7	318.5
2 mg. N.	250.7	340.0	345.3	378.3	420.9
8th Day†					
1 mg. N.	..	265.5	229.7	306.3	234.1
2 mg. N.	..	403.0	367.0	394.0	370.5

* Extract prepared after 4 days' sprouting.

† 8

It will be seen from the table that the enzyme-forming efficiency of the nitrogen associated with extracts of etiolated seedling, at both the levels of nitrogen tried, is higher than that of the bran extract (papain digest); at one milligram level, the efficiency is twice as high.

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Section of Fermentation Technology,
Indian Institute of Science,
Bangalore, 13th March 1946.

¹ Bindal, A. N., and Sreenivasaya M., *J. Sci. Ind. Res.*, 1945, 3, 386.

² Raghavendra Rao, M. R., and Sreenivasaya, M., *Curr. Sci.* 1946, 15, 25.

³ *Ibid.*, 1946 (in press).

⁴ Bindal, A. N., and Sreenivasaya, M., *J. Sci. Ind. Res.*, 1944, 2, 245.



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THE INDIAN MICA INDUSTRY

THE problems of the Indian mica industry have been critically examined in a recent report* issued by the Mica Enquiry Committee, appointed by the Government of India in the latter half of 1944, to enquire into the many aspects of the industry including grading and marketing, conservation, research and utilization. The Committee was called upon to report also on "the desirability of setting up a suitable machinery, whether by the appointment of a Central Mica Committee or otherwise, to watch the interests of the mica trade and industry."

Mica is a mineral of key importance with an assured export market. Before the war, over 70 per cent. of the world's supply of muscovite mica came from India. India's exports increased both in volume and value during the war, and in 1944, mica worth nearly 2.75 crores of rupees were exported. The industry employs 2.5 lakhs of labourers directly or indirectly in its mines and factories. India's pre-eminence in the industry is as much due to the rich deposits as to the cheap labour, which by years of experience has acquired superior skill and efficiency. So high is the reputation of the Indian mica worker that sheet mica is sent to this country from Brazil, the United States of America and Canada to be split. The industry with all these advantages has suffered from serious defects of organization. The methods of mining are primitive and wasteful; illicit dealings in mica are prevalent to an appreciable degree; labour is ill-paid and discontented; the system of marketing does not ensure a fair price to the Indian producer. The industry, generally speaking, has suffered

from neglect and the need for organizing it on sound lines is urgent.

Conservation

There is hardly any reason to apprehend the exhaustion of India's mica resources. The real danger to conservation lies in improper methods of mining. The Report stresses that systematic mining should be made compulsory in deep mines. It recommends also the compulsory maintenance of records of abandoned mines and prospecting pits by the Indian Mines Department. Technical assistance must be given to the miners and the employment of qualified mine managers should be made compulsory. To guard against loss of mica caused by premature stopping of mines, it should be laid down statutorily that an approach should be left to the deepest working point except when a mine is stopped with the approval of the Chief Inspector of Mica Mines. The Committee proposes the establishment of a separate Inspectorate of Mica Mines and the application of the Mines Act to all mica mines except shallow ones or those employing 20 or less workers. The examination and revision of the complicated regulations and rules under the Mines Act and the relaxation in the case of small mines are also suggested.

Research and Utilization

The Committee's observations on the utilization of mica in India are of special interest. There is no record, official or non-official, of the quantity of mica utilized in India. The quantity utilized is estimated at about 5 per cent. of the total output. The main use of mica is in the manufacture of electrical apparatus. The Indian Railways use a large quantity of block mica for

*Report of the Mica Enquiry Committee (Manager of Publications, Delhi), 1946.

purposes of insulation and for repair of electrical machinery. Micanite is produced within the country in limited quantities. Although the quality of the product has greatly improved in recent years, there is room for further advance. The market for Indian micanite is somewhat limited within the country in view of the fact that large-scale user industries do not exist. Even those that exist do not all use Indian micanite. The Report observes: "If the Indian manufacturers are prepared to improve their product so that other industries will not suffer by being compelled to use it, we would recommend the imposition of tariffs to protect the Indian micanite industry." Such improvement as the Committee desires can be effected only through technological research. Ground mica finds a surprisingly large number of uses, e.g., in paints and coating compositions, rubber compositions, lubricants in the moulding and vulcanizing of motor tyres, moulded electrical insulation and heat insulation. The Committee has found very little evidence of its use in India. "With the numerous uses to which ground mica can be put, it is a matter for great regret that India's resources of waste mica should be allowed to go out of the country in this manner." Grinding of mica is by no means a highly complicated process, and there seems to be no reason why with ample supplies of desirable scrap at hand and cheap labour, India should not become the principal supplier of the world market. Unfortunately, the problems of mica utilization have received but scant attention in this country and the producers have contented themselves with selling their raisings in foreign markets at some profit to themselves.

The need for research becomes even more compelling, when it is realized that India's present position as the world's principal supplier of mica is by no means unassailable. During the war, Brazilian mica came into the American market. Cheap Mexican labour was employed for splitting the mica. Russia is another source of muscovite mica and the possibility of her entering the world market as an exporting country cannot be ignored. Muscovite mica occurs also in Australia and Tanganyika, and vigorous explorations for mica are being pursued in other countries also. The possibility of developing substitutes for mica and even synthetic mica cannot be dismissed complacently. Alternative materials have been employed successfully in

apparatus in which mica was being traditionally used. It is reported that synthetic mica was produced in Germany during the war period on a laboratory scale.* So far, however, no material has been produced on a commercial scale which threatens the position of mica.

The Committee suggests the establishment of a Mica Marketing Control Board, which besides watching ordinary trade interests, should also conduct research and development. The desirability of constituting a Central Mica Committee on the lines of other commodity committees, to control and direct research and development on mica may be worth considering. Alternatively, the mica producers may be encouraged to form a co-operative research organization. The chief requirement is a research station under the direction of an eminent scientist with laboratory facilities for conducting original investigations on the production, properties and uses of all types of mica, and for evolving standards of grading. The organization will have to keep in touch with technical developments relating to mica in other countries, and maintain, if it is deemed necessary, research units in the United States of America and in the United Kingdom, the two principal importers of Indian muscovite mica.

The Committee proposes a levy of 6 per cent. *ad valorem* on all mica exports for financing the establishments suggested in the Report and for research in the interests of the industry. Estimating the annual export of mica at Rs. 1,00,00,000 the suggested levy would yield an annual income of Rs. 6,00,000. The Committee recommends the allotment of a third of the revenue to the Mica Marketing Control Board, which will be responsible for research. The income should be supplemented, if necessary, by contributions from Central and Provincial Governments. It may be assumed that the finances required for research can be found. The immediate need is to ascertain the basic research requirements of the industry and to prepare plans for bringing a research organization into being.

* Synthetic mica is obtained by fusing together carefully purified silica, metallic oxides, sodium and potassium fluoride and silicofluorides in graphite crucibles. The melt is carefully cooled, particularly within the critical range 1270°-1230° C., in a strong magnetic field at right angles to the vertical axis of the crucible, when mica blocks with the basal cleavage are obtained (*cf.* C.T.J., 1945, 117, 670).

THE EMPIRE SCIENTIFIC CONFERENCE

THE Empire Scientific Conference organized by the *Royal Society* is due to open in London on 17th June 1946, and will be formally inaugurated by His Majesty the King. The primary purpose of the Conference is to provide an opportunity for exchange of views upon scientific problems which are of practical importance to the scientists throughout the Empire, and in particular, to survey the progress made during the war years. The Conference will, where appropriate, also make recommendations about the ways and means of achieving the greatest practical measure of collaboration between scientists and organizations in the various parts of the Commonwealth for the solution of these problems. The successful war-time collaboration in scientific research between the units of the British Commonwealth on the one hand, and the United Kingdom and the United States of America on the other, has raised the important question of continuing and strengthening scientific collaboration through permanent liaison machinery.

The Indian Official Delegation to the Conference will be led by Sir Shanti Swarup Bhatnagar. The members of the Delegation (official) are: Sir Shanti Swarup Bhatnagar (*Leader*), Mr. D. N. Wadia, Col. Sir S. S. Sokhey, Dr. M. S. Krishnan, Dr. S. L. Hora, Dr. P. C. Mahalanobis, Khan Bahadur Mian M. Afzal Hussain and Dr. J. N. Mukherji. The Non-official Delegation consists of Sir J. C. Ghosh, Dr. M. N. Saha, Dr. H. J. Bhabha, Dr. K. S. Krishnan, Dr. Birbal Sahni, Dr. M. R. Siddiqui and all the members of the Official Delegation. There is no leader to the Non-official Delegation; Sir Shanti Swarup Bhatnagar will be the *Convener*. Dr. K. N. Mathur will act as the *Secretary* to the Delegation.

The Royal Society Conference will last three weeks—from 17th June to 8th July—and will be followed by an official conference lasting a fortnight. During the first few sittings at London, representatives of the United Kingdom, the Dominions, India and the Colonies will survey the organization of science in their respective territories, in the spheres of Government, industry, universities and learned societies. Discussions have been organized on interchange of scientists throughout the Empire, future of scientific liaison offices established during the war,

dissemination of scientific information within the Empire including dissemination of scientific news to the public generally and of scientific and technical information to industry as well as abstracting and library services, and natural products of the Empire and the chemical industries based on them.

The Conference will move to Cambridge during the second week. Among the important subjects scheduled for discussion at Cambridge are: Survey of problems in agricultural science in the Empire, need for the survey of the mineral resources of the Empire on a more adequate scale than hitherto and with more up-to-date methods, measures to secure greater uniformity in physical standards of measurement and the use of units, terms and symbols, collection and interchange of scientific material and the safeguards necessary to minimize the risk involved in the distribution of biological materials.

The Conference will then move to Oxford. The programme of the Conference includes, besides an address by Sir Henry Tizard at Rhodes House and a reception, discussions on problems in agricultural science in the Empire, modern methods of mapping and exploration by air including the use of recent radio technique in ordnance survey, present status of the science of nutrition with particular reference to the special problems of the Empire and the survey of the nutritional status of the indigenous people of the colonies, and problems of land utilization and conservation including forestry, soil erosion, and irrigation. The Conference will return to London and hold its final session on the 8th July.

The Official Conference is due to open in London on 9th July and is expected to continue till 20th July. A number of interesting discussions are tabled for the evening sessions of the Conference. The evening discussions are expected to be of a more intimate nature and no formal papers are being prepared for them. The subjects are not finally decided yet, but the following items are at present on the list:

- (1) Nuclear research.
- (2) Scientific aspects of radio communication.
- (3) Meteorological research and climatic surveys.
- (4) Cosmic rays.
- (5) Fishing industry.
- (6) Soil surveys.
- (7) Sampling methods.
- (8) Special biological topics including paleobotanical research.

It is anticipated that many of the decisions which might be taken at the Royal Society Conference may require a background of Government policy, and perhaps official support, for their full implementation. The Official Conference which will immediately follow the Royal Society Conference will

thus be a desirable complement to it. It will be called upon to consider the best means of ensuring the fullest possible collaboration between the civil Government scientific organizations of the Commonwealth and to make formal recommendations for the approval of the Governments represented.

LONDON SHELLAC RESEARCH BUREAU

THE *Indian Lac Cess Committee* has closed down (from 31st March 1946) the Lac Research Laboratory which was housed in the School of Mines, Edinburgh.

The history of lac research in the U.K. financed by the *Indian Lac Cess Committee* dates back to 1929, when a Special Officer, Lac Inquiry, was appointed to bring to the notice of the lac-consuming industries the special merits of lac as an industrial raw material. It was soon realized that intensive research on the chemistry and technology of lac in close co-operation with the consuming industries was essential if lac was to withstand competition from synthetic resins. In 1933, the *Committee* decided to appoint three Indian scientists to carry out research in the U.K.; two of them were engaged in problems connected with the utilization of lac in paints and plastics, and the other on lac utilization in the electrical industry. Additional staff was soon added and an organized Shellac Research Bureau was established in the Chemical Engineering Department of the University of London. During the war period, the headquarters of the laboratory were shifted to Edinburgh. The Bureau has carried out work of substantial value to industry, and greatly extended the knowledge on the fundamental properties of the natural resin. The results obtained have been published in a series of *bulletins* and *technical papers*. *Abstracts* of published literature on shellac have been issued at regular intervals.

In a statement published in *Chemical Age* (30th March 1946), Dr. B. S. Gidwani has traced the history of lac research in the U.K. and has discussed the future of shellac.

As a raw material for industry, lac is faced with serious competition from several new synthetic resins developed in the U.K. and U.S.A. during the war years; research and large-scale development work is essential if lac has to survive the competition. India holds a monopoly for lac and is keenly interested in extending its industrial applications. The closing down at this time of the research unit which had built up a large volume of goodwill among the industrialists and a high credit among scientific and technical institutions in the U.K., is to be regretted.

The decision to close down the Laboratory at Edinburgh is attributed to financial difficulties. The steps which the *Indian Lac Cess Committee* proposes to take for continuing research in the U.K. are not known. A part-time officer, it is understood, is being retained to maintain liaison with industry. Problems requiring laboratory investigations will be referred to the *Indian Lac Research Institute* at Namkum. This laboratory is well equipped and staffed, and it has to its credit a large volume of useful work on the propagation and industrial utilization of lac. Development work, however, is likely to suffer. It is now widely realized that such work progresses most successfully when it is carried out in collaboration with industry. Nearly 90 per cent. of lac is exported, and there is hardly any consuming industry in this country. This constitutes the main reason for continuing research in the U.K. It is to be hoped that development research on this important natural resin would be continued and that its threatened extinction from the industrial field would be removed for ever.

BUILDING RESEARCH CENTRE

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

THE first meeting of the Building Research Committee of the *Council of Scientific and Industrial Research* held in Delhi on 5th September 1944, considered the progress of work on building problems in recent years in this country. The Committee had before it a note by the Director of Scientific and Industrial Research, dealing with the great strides that have been made in the U.S.A. and the U.K. on the subject, and pointing out the various fruitful lines of work which may be followed in India.

The building industry, it should be remembered, is a major industry, and besides design and construction, the manufacture and preparation of materials of construction have assumed great importance. A systematic study of the fundamental properties of building materials would be of great value, leading to the efficient utilization of available materials and the development of new materials having improved properties. The climatic conditions and geological features vary very widely within the country necessitating the development of specifically adapted designs and methods of construction for different regions. There are also other problems, such as ventilation, soil stabilization, fireproofing, acoustic treatment, air-conditioning, etc., which must receive due attention.

The Committee at its first meeting decided that engineering colleges and other institutions in the country should be approached to elucidate their interest in various research problems and to survey the research facilities available. As a result of this inquiry, the *Board of Scientific and Industrial Research*

decided that the possibilities of locating a research centre at the Thomason Engineering College, Roorkee, should be explored. As a result of the discussion between the Director of Scientific and Industrial Research, the Principal of the Thomason Engineering College, Roorkee, the Chairman and the Secretary of the Building Research Committee, held on 28th July 1945, a preliminary plan for establishing such a centre was worked out.

At the second meeting of the Building Research Committee, held in Roorkee on 28th of August 1945, detailed plans for the research centre were evolved and the co-operation of the Government of the U.P. was enlisted.

The staff consisting of an Assistant Director, three Research Officers, three Research Assistants and others, will be shortly appointed by the *Council of Scientific and Industrial Research*. The staff will work under the administrative control of the Principal of the Thomason Engineering College, Roorkee, the technological control of the activities of the centre being vested in the *Council* through its Building Research Committee. Laboratory accommodation and gas, water, workshop and library facilities of the Engineering College will be made available to the research staff, who are expected to commence their work by July 1946.

This centre, it is hoped, will form the nucleus for the development of a National Building Research Institute in the not too distant future.

L. C. V.

PALUDRINE—THE NEW DRUG FOR MALARIA

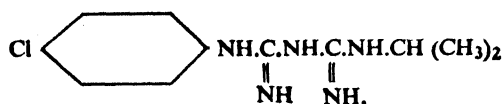
By Dr. D. G. DAVEY

(Biological Department, Imperial Chemical Industries, Manchester)

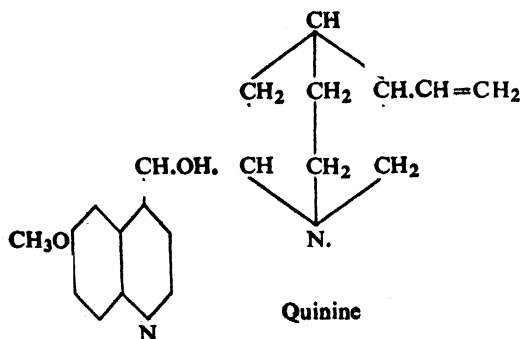
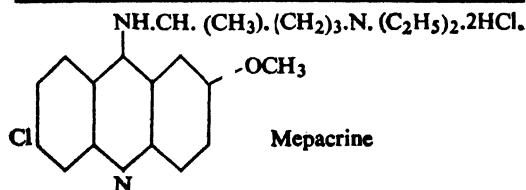
THERE are three points of major interest concerning paludrine, the new drug for malaria which was announced some time ago. First, its chemical constitution is quite unlike that of any other drug used for malaria; secondly, it has an action on stages of the parasite in the vertebrate host which are untouched by mepacrine and quinine; and, thirdly, there is a very wide margin between the doses which are effective in controlling the clinical symptoms of malaria and those which produce even minor toxic signs. Each of these points will be considered in turn.

Constitution

Paludrine belongs to the biguanide class of compounds and has the following constitution—



Mepacrine,² on the other hand, belongs to the acridine class and quinine to the quinoline class. For comparison with paludrine the constitutions of each of these two drugs is given below.



At present two salts of paludrine are being made. Paludrine hydrochloride, which is

used for oral administration, is a white crystalline powder which melts at approximately 240° C.; it is slowly soluble in water to the extent of about 1 per cent. at 20° C. Aqueous solutions of it can be boiled without decomposition. Paludrine acetate, which is being used for intravenous treatment, is very similar to paludrine hydrochloride except that it is about twice as soluble in water; its melting point is 188.5 to 189.5° C.

Action of Paludrine against Exoerythrocytic Forms of the Malarial Parasite^{1,2}

In many species of avian malaria so-called exoerythrocytic forms have been demonstrated. They may be found co-existent in the same host with parasites of the red blood corpuscles, and Huff and Coulston³ have shown beyond any possibility of dispute that they occur in some species following the introduction of the sporozoites and preceding the appearance of parasites in the red cell; that is to say, the sporozoite when it is injected into the vertebrate host does not, as Schaudinn believed, penetrate directly into the red blood corpuscles but first undergoes a cycle of development in cells of the solid tissues, actually in cells of the reticulo-endothelial system. Possibly after one generation has undergone development in these cells, possibly later, some parasites develop in the red cells. At the same time some of the exoerythrocytic forms continue as parasites of the reticulo-endothelial system, and with succeeding generations they extend their distribution to include endothelial cells lining capillaries in various organs of the body. This cycle of development has been demonstrated to hold good for infections of *Plasmodium gallinaceum* in chicks and of *P. relictum* in canaries³, but there is a good deal of circumstantial evidence to show that it is true also of human malarial parasites, particularly of *P. vivax*. A general scheme which embraces all possibilities is as follows¹.

Both in avian malaria and in human malaria the sporozoites exist free in the blood only for a very short time—not more than half an hour—and consequently it will

Sporozoites → exoerythrocytic forms → parasites in the red blood corpuscles

persistent as long as infection lasts in many species

probably be very difficult indeed to discover a drug which will kill them. A drug which would accomplish this would, of course, be a casual prophylactic drug, but one to serve this purpose equally well, that is, prevent parasites developing as far as the blood forms, would be one which killed the first generation of exoerythrocytic forms. Also, if exoerythrocytic forms are persistent in benign tertian malaria any drug which will cure this infection must have an action on these forms as well as on blood forms.

It can be shown in experiments with avian malaria that drugs such as mepacrine and quinine have no action on the exoerythrocytic forms, and it is known, of course, that they are not true causal prophylactic drugs in human malaria and neither of them will cure benign tertian malaria with any degree of certainty. It was decided, therefore, during the intensive search which was made during the war years for new antimalarial drugs, to look for substances with an action not only on blood forms but also on exoerythrocytic forms. Paludrine is the best result to date of these researches.

Causal prophylactic experiments with paludrine in human malaria have been done by Brigadier N. Hamilton Fairley and his staff at the Australian Army Research Station at Cairns⁴. He has shown that paludrine even in small doses has a true causal prophylactic action in malignant tertian malaria, presumably by killing the first generations of exoerythrocytic forms, and that it also has an action on these forms in benign tertian malaria. Unfortunately, however, those of benign tertian malaria are more refractory to the drug than are those of malignant tertian malaria. Briefly, the more important of Brigadier Fairley's results are as follows:—

(a) A single dose of 100 mgms. of paludrine taken by some, but not all volunteers the day after they were bitten by mosquitoes heavily infected with sporozoites of malignant tertian malaria, or on the second day after,

completely prevented any signs or symptoms of malaria from developing.

(b) A dose of 100 mgms. taken daily on each of three or more successive days by volunteers who had been similarly exposed to infection completely protected all of them.

(c) A dose as small as 25 mgms. taken daily throughout the time they were exposed to the bite of infected mosquitoes, and for a few weeks afterwards, completely protected each of two volunteers from malignant tertian malaria.

(d) A dose of 100 mgms. taken daily prevented parasites of benign tertian malaria from entering the blood stream, but following the cessation of treatment symptoms of malaria eventually appeared, although not until several months had elapsed. This result shows that paludrine at this dosage is only inhibitory to the presumed exoerythrocytic forms of benign tertian malaria and not lethal to them. Experiments at higher doses (300 mgms. a day and more) have been done^{4,5}, and many months have gone by without all the volunteers who were exposed to infection exhibiting clinical symptoms of malaria. It may be that some of these volunteers have been completely protected but it is too early to make a definite statement.

Clinical Treatment^{4,6,7,8}

Paludrine was first tried in the treatment of clinical cases of human malaria by the staff of the Liverpool School of Tropical Medicine. The more important of their results together with the results of clinical treatments which have been obtained by Brigadier Fairley and his collaborators in Australia are as follows:—

(a) A single dose of 100 mgms. is sufficient to control the clinical attack of both malignant and benign tertian malaria⁴. Experiments are continuing with the "single dose" treatment.

(b) A dose of 10 mgms. given twice daily throughout the period of a clinical attack is sufficient to control the symptoms of benign tertian malaria and to establish a clinical cure⁶.

(c) It is not until doses of 500 mgms. are given twice daily or until doses of 300 mgms. are given three times daily that even minor toxic signs are apparent. These minor toxic

signs have included a slight epigastric discomfort in some patients and nausea in others. Treatment with 500 mgms. twice daily has continued for as long as one month without effects more adverse than those mentioned, and a small number of patients have also received 750 mgms. twice daily for a month without exhibiting further symptoms of intoxication. It appears that it is not until single doses of 1 gm. are given that definite symptoms of toxicity become evident. These may include diarrhoea, and one case, too, passed red cells in his urine suggestive of an irritant action of the drug on the pelvis or the bladder. There was no evidence of parenchymatous damage to the kidney.

(d) Treatment with 100 mgms. three times daily for 10 days cured 64 out of 65 cases of malignant tertian malaria⁴. Experiments are being made to determine if larger doses for a shorter time have the same effect.

(e) The relapse rate in benign tertian malaria following treatment with low doses such as 25 mgms. twice a day is high and on a par with what might be expected from treatment with quinine or with mepacrine. Treatments are being made with higher doses, for example, 250 mgms. twice a day for 10 days and 500 mgms. twice a day for 14 days, but it is too early yet to say definitely what the relapse rate following these treatments is.

(f) Quartan malaria is also susceptible to treatment with paludrine but too few cases have been treated to warrant general conclusions.

(g) Paludrine has an indirect gametocidal action in both benign and malignant tertian malaria⁴. When blood smears are examined from patients who are suffering from these diseases, and who have been treated with paludrine, the gametocytes appear unharmed, but it has been shown in Australia that mosquitoes do not become infected by them. The action of paludrine in preventing the gametocytes developing in the mosquito is exerted in the stomach of the mosquito.

Work is proceeding in many hospitals and research institutions on paludrine, and it will be some time before the full qualities of the new drug are apparent. So far its main attributes appear to be:

- (i) It is colourless in solution and will not stain the skin.

- (ii) It is remarkably free from unpleasant side effects at therapeutic doses.
- (iii) The effect of a single dose of 100 mgms. in controlling clinical attacks, and the fact that a relapse does not occur after such a treatment for several weeks, means that this small dose taken once a week is likely to prove an efficient suppressive.
- (iv) There is every chance that by increasing this single dose to 200 mg. or to 400 mg.—and this can be done without fear of toxic effects—a perfectly satisfactory single dose for establishing clinical cure will be found. Such a treatment, of course, would be of inestimable value in campaigns against malaria and in the control of epidemics.
- (v) It is a causal prophylactic drug against malignant tertian malaria at easily tolerated doses; it could, therefore, be used to eliminate this disease.
- (vi) It has at least a partial causal prophylactic action against benign tertian malaria.
- (vii) Radical cures of malignant tertian malaria are obtained by a simple course of treatment.
- (viii) It is possible that it can be used to lower the relapse rate of benign tertian malaria.

References

- ¹ Curd, F. H. S., Davey, D. G. and Rose, F. L., *Ann. Trop. Med. & Parasitol.*, 1945, **39**, 208.
- ² Davey, D. G., *Ann. Trop. Med. & Parasitol.*, 1946 (in the press).
- ³ Huff, C. G. and Coulston, F., *J. infect. Dis.*, 1944, **75**, 231.
- ⁴ Australian Army Research Unit, Cairns—*Reports of Brigadier N. H. Fairley*. (a) Brig. N. H. Fairley, Director—*personal communications*; (b) Lt.-Col. R. Blackburn, Physician in charge—*personal communications*; (c) Major Gregory, Major Tonge, Pathologists—*personal communications*; (d) Major Mackerras, Entomologist—*personal communications*.
- ⁵ Adams, A. R. D., Davey, D. G. and Davey, T. H.,—*unpublished experiment*; Anon. *B. M. J.*, (1945), ii, 653; Anon. *Lancet*, (1945), ii, 639; Anon. *Nature*, (1945), 17th November; Anon. *Lancet*, (1946), i, 278.
- ⁶ Adams, A. R. D., Maegraith, B. G., King, J. D., Townshend, R. H., Davey, T. H. and Havard, R. E., *Ann. Trop. Med. & Parasitol.*, 1945, **39**, 225.
- ⁷ Johnstone, Major, R. A. M. C., Colchester Military Hospital, *personal communication*.
- ⁸ Maegraith, B. G., Adams, A. R. D., King, J. D., Townshend, R. H., Davey, T. H. and Havard, R. E., *Ann. Trop. Med. & Parasitol.*, 1945, **39**, 232.

Contributed by Dr. D. S. Davey, at the request of the Editor.

WHITE CLINKER FORMATION IN PORTABLE PRODUCER-GAS PLANTS

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BOTH in a stationary and a portable producer-gas generator, the formation of clinker is a troublesome factor. In large stationary producer-gas plants, clinker troubles have largely been overcome by fire zone temperature regulation through the use of controlled quantities of steam. In portable gas plants, as used in India at present, steam injection has not been generally adopted. The formation of clinker in the fuel bed is, therefore, one of the serious factors affecting plant performance. Bulky masses of clinker may cause blocking of air passages in the fire grate, arching of the fuel, fluxing and fusion of the fire-brick or clay lining of the generator, and sometimes even of the iron of the grate. In cross-draught plants, in particular, a big lump of clinker at the tuyère mouth may seriously block the air inlet and elsewhere it may cause shifting of the fire-zone from the centre to the side of the generator. In extreme cases, it may even fuse and damage the generator shell, thereby rendering it unfit for use. Its inert mass reduces the area of the fuel bed, invariably resulting in poor quality gas and sluggish performance of the engine.

Clinker formation in producer-gas generators has been investigated by a number of workers using coal, coke, anthracite, etc., as fuel, but very little work seems to have been done using charcoal. According to Varma and Dey¹, formation of clinker is not entirely due to the nature of the ash or its contents but also to certain extraneous factors. Ramaswami and Dey² are of the opinion that certain types of clinker observed in actual practice, namely, fused clay glazed, fused stone glazed, and dull spongy mass clinkers are due to the earthy impurities such as clay, clayey or sandy loam, limestone, shale and sandstones of various types commonly found mixed with charcoal. It is further claimed that, when these impurities are eliminated, the clinker formation disappears.

Producer gas testing authorities from Bombay reported the formation of a fluffy white clinker of mysterious origin, which at first received little attention, it being tacitly assumed to have originated from extraneous impurities in charcoal as described by Ramaswami and Dey (*loc. cit.*). Later, Dr. H. B. Dunncliff of the War Transport Department noticed the massive formation of similar clinker which occurred during a long run from Bombay to Delhi in a Powell gas plant fitted to a departmental Ford station wagon. The charcoal used in this run had been purchased in Bombay and the general appearance of the clinker was so striking that it was considered worth while to analyse it chemically. The results of analysis, as given in Table II, column 2, under "Charcoal No. 1," showed a high preponderance of lime and magnesia, which led to the belief that it was possibly due to some limestone impurity in the charcoal.

Later on, similar clinker was observed to form during reliability and performance trials on a Chevrolet 3-ton truck fitted with a Simpson plant, using charcoal purchased in Delhi. With a view to establish the source as being extraneous limestone impurity, certain batches of charcoal were carefully hand-picked and used in road trials in this truck. Formation of clinker still persisted.

This type of clinker may be described as a coral-like mass, having a milk-white colour, very light in weight and highly friable in texture. Because of its "fluffy" nature, even a small quantity of it was observed seriously to affect the performance of the gas plant. It was, therefore, considered worth while to investigate its source and find ways and means to prevent its formation.

Experimental

A quantity of charcoal (designated in Table II as "Charcoal No. 2") used for the road trial runs mentioned above, during the course of which clinker formation occurred, was carefully sorted out by hand-picking all foreign matter and heavy, suspicious pieces

of charcoal, etc. The charcoal could thus be divided into 14 different fractions involving 7 fractions of foreign matter and 7 of charcoal, as indicated in Table I. Chemical analysis of charcoal and general considerations showed that none of the foreign matter fractions could be directly or indirectly related to the high percentage of lime found in the clinker. The ash content of the various charcoal fractions corresponded closely to that of the charcoal except in the case of the barked charcoal fraction, which gave an ash content of 19.5 per cent. as compared with 8.8 to 9.9 per cent. for other fractions.

Now, the principal metallic components of wood ash are known to be calcium, potassium and magnesium. Aluminium, iron, and sodium are also present to a limited extent. Wood ash is often rich in calcium oxide, constituting one-half to three-quarters of the total ash. Crystals of calcium carbonate and of calcium oxalate frequently occur in wood³. It is also understood that the bark of sal (*Shorea robusta*) has been found to contain calcium oxalate crystals. It was, therefore, considered most likely that the bark of certain Indian trees, from which this charcoal had been prepared, contained calcium oxalate or calcium carbonate, or both.

In view of the high ash content shown by the barked fraction, it was considered worth while to further examine the charcoal No. 2. For this purpose, three fractions were taken (i) bark, (ii) charcoal powder removed to a depth of 1/16" adjacent to the bark, (iii) the remainder of heart charcoal. Ash content of these fractions and analyses of ash are given in Table II, together with the analysis of clinkers obtained from this particular variety of charcoal when burnt in a producer-gas plant. Clinker analysis from Bombay Charcoal (No. 1) is included for comparison. From these results, it is evident that:

- (i) The bark of the charcoal contains a higher percentage of ash than the interior fractions and is much richer in calcium oxide.
- (ii) Bark ash contains almost the same proportion of calcium and magnesium oxides as the clinker; in fact, silica, iron and aluminium oxides are also present in comparable amounts.
- (iii) The ash content of the outer layers underlying the bark is higher than that of the heart charcoal.
- (iv) The composition of clinker resembles that of ordinary cement clinker, all

TABLE I. *Fractions Obtained by Sorting Charcoal No. 2.*

No.	Foreign matter fractions	Weight %	No.	Charcoal fractions	Weight %
1	Dry cow dung	0.0003	8	Small unburnt wood pieces	0.142
2	Scrap iron	0.0004	9	Unburnt and half burnt twigs	1.23
3	Cement-sand plaster	0.012	10	Barked charcoal	1.41
4	Brick and earthenware	0.004	11	Unburnt heart heavy charcoal	0.665
5	Unburnt clay	0.005	12	Half burnt charcoal	1.97
6	Clay pieces partially burnt, black on breaking	0.054	13	Burnt and unburnt pieces with hard knots	1.41
7	Mineral matter coloured dark throughout the mass	0.033	14	Well burnt charcoal	91.79

TABLE II. *Chemical Analysis of Clinkers and Charcoal Fractions per cent.*

Constituents	Charcoal No. 1		Charcoal No. 2		
	Clinker from Powell plant on station wagon	Clinker from Simpson plant on Chevrolet truck	Bark	1/16" thick layer filed after removal of bark	Heart charcoal
Ash			19.5	11.78	8.75
<i>Analyses</i>					
1 SiO ₂	1.98	2.2	2.55	11.50	13.50
2 Fe ₂ O ₃ and Al ₂ O ₃	9.33	12.3	9.41	6.25	4.90
3 CaO	71.33	78.3	78.00	26.37	28.71
4 MgO	9.93	3.2	4.50	4.47	4.62
5 CO ₂	3.22	3.0			
6 R ₂ O (Sodium and Potassium)	1.4	0.9	4.8	13.5	14.1
Total	97.19	99.9	99.26	62.09	65.83

the constituents of which are particularly present in the bark ash.

- (v) Bark ash is not so rich in alkalies as the charcoal ash, and clinker is even more deficient in alkalies. Furthermore, the totals indicate that further constituents such as chlorides may be present in charcoal ash, which are absent in bark ash. These observations show that, during combustion in a gas plant, alkalies and chlorides are probably carried away with the ash into the ash box or eliminated by volatilization in combination with chlorides. A small fraction of alkalies, however, is probably utilized as flux for clinker formation.

While studying the ash content of charcoal from Tasmanian timber, Jaeger⁴ came to similar conclusions. It, therefore, became evident that the bark may be responsible for the white clinker formation. Further confirmation of this view was obtained by actual bench tests and road tests on producer-gas plants.

Two samples of charcoal (No. 2), one free from bark and another artificially enriched with bark, were used in a *T.V.S.* down-draught gas plant. The power testing unit was a six-cylinder Chevrolet bench test engine (29.4 h.p., R.A.C. rating) directly coupled to a Heenan and Froude type of hydraulic dynamometer for absorbing the engine power. The engine was run on producer gas for maximum output at 1,500 r.p.m. with full throttle opening. The results of the bench test are given in Table III.

TABLE III

Bench and Road Test results on Charcoal free from bark and rich in bark using Charcoal No. 2

Item	Bench tests		Road tests
	Bark-rich charcoal	Bark-free charcoal	Ordinary run of charcoal
1. Charcoal consumed per b.h.p. hour	1.87 lb.	1.85 lb.	..
2. Ash, %	19.5	7.23	8.75
3. White clinker formed, %	2.59	0.172	1.82

Though the consumption of charcoal per b.h.p. hour in the bench tests was substantially the same, yet the amount of clinker formed widely varied in the two cases. These bench tests are further supported by the road trials conducted on the experimental

truck, when the weight of clinker formed was 1.82 per cent. of the total weight of charcoal free from foreign matter. The charcoal used for these experiments was from the same lot.

Another series of more detailed bench tests were conducted on a different batch of charcoal (No. 3) obtained from another source, using the same equipment described above. The results of chemical analyses of the ash and those of the bench tests are summarized in Table IV. Complete absence of clinker formation in bark-free and ordinary run of charcoals may be noted and compared with 1.5 per cent. of clinker formed in the case of bark-rich charcoal. Of particular interest in Table IV are the consumption figures. Against 1.87 lbs. per b.h.p. hour of bark-free charcoal, 2.68 lbs. of barky charcoal were consumed, i.e., an increment of 43 per cent. Even ordinary run of charcoal showed an increment of about 10 per cent. in consumption over that for bark-free charcoal.

TABLE IV

Results of Bench Tests on Various Fractions of Charcoal No. 3

Item	Bark-free charcoal	Ordinary run of charcoal	Bark-rich charcoal
Ash, %	2.0	1.95	14.90
<i>Analysis of ash</i>			
SiO ₂	9.15	10.20	8.15
Fe ₂ O ₃ & Al ₂ O ₃	15.00	14.80	13.25
CaO	53.70	54.60	64.10
MgO	1.56	1.66	2.00
R ₂ O (R, sodium & potassium)	12.6	13.5	9.5
Total	92.01	94.76	97.00
<i>Bench Tests</i>			
1. Charcoal to start with, lbs.	112.0	103.0	70.0
2. Charcoal left after the test in generator, lbs.			
(a) graded	10.00	39.00	2.50
(b) fines	6.25	6.75	2.75
3. Ash removed from generator bottom and ash box, lbs.	9.25*	9.00*	2.25
4. Ash removed from cooler and filters, lbs.	2.50*	3.00*	...
5. Charcoal consumed, lbs.	85.77†	46.15†	64.75
6. Consumption of charcoal in lb./b.h.p. hour	1.87	2.05	2.68
7. Clinker, lbs.			
(a) hard grey	0.0287	0.0243	0.722
(b) white (lump and powder)	0.0	0.0	1.49
8. White clinker produced as per cent of charcoal consumed.	0.0	0.0	2.3

* Charcoal powder mainly mixed with ash.

† Corrected for charcoal powder mixed with ash.

These tests clearly demonstrate that the bark present in the charcoal is mainly responsible for the formation of white spongy clinker. As a matter of fact, in certain pieces of clinker, the structure of bark was clearly discernible, as, though pieces of bark had been petrified during combustion.

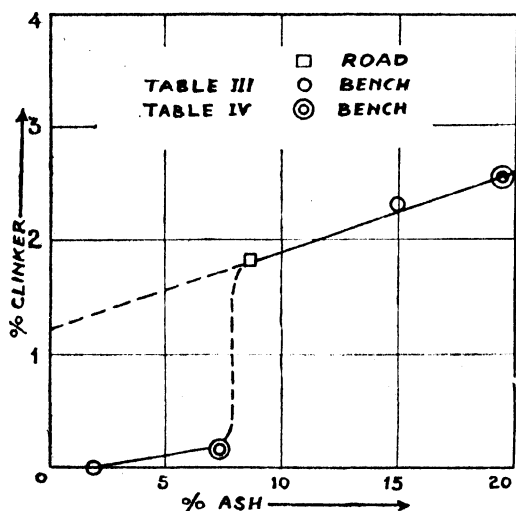


Fig. 1

In Fig. 1 are plotted the percentages of white clinker formed during the two series of bench tests and one road test against the ash content of charcoals used. It will be seen that at values of ash lower than 7-8 per cent. white clinker formation is negligible, but above this value, considerable quantities of clinker are formed, which bear a linear relation to the ash content, viz.,

$$C = 1.2 + 0.070A,$$

where C is the percentage white clinker formed from charcoal containing A per cent. of ash, for values of $A > 8$. The accuracy of this equation must not be overestimated as the data on which it is based are very meagre.

The reason why clinker formation is suddenly accelerated beyond a certain ash content, may be sought in the fact that the operating temperature of the fire zone varies considerably, depending on whether clinker is formed or not. In other words, once the clinker formation is initiated, the temperature begins to increase and the clinker formation accelerated in beds rich in bark, while, in ordinary charcoal low in bark content or

free from it, the temperature is not likely to rise to such an extent as to promote clinker formation from such small quantities of clinker-forming ash constituents as may be present. In one case while burning charcoal rich in bark, it was noticed that the fuel bed temperature rose so high as to melt a portion of the cast iron grate due to the formation of clinker which blocked a portion of the grate, thereby reducing the fire zone to a very small size.

In almost all the pamphlets issued for the information of the vehicle owners and drivers and for the operators of wood charcoal kilns, the Australian authorities⁵ have laid great stress on the use of bark-free charcoal in gas producers for vehicles and tractors and for burning of timber stripped free of bark for the production of charcoal. They, however, have not indicated the reasons for avoiding bark in either case. The above experiments clearly demonstrate that the baky charcoal leads to the formation of white clinker, which results in poor gas quality and unsatisfactory performance of the engine.

In general, it has been found that young wood may be richer in ash than old wood and the wood of branches and roots are higher in ash content than the wood in the trunks of trees³. It is, therefore, suggested that, during charcoal burning, twigs and other baky wood shavings may be utilized for the initial lighting up fires in the kilns used for the preparation of charcoal for use in gas producers. It is also recommended that the charcoal for use in gas producers should be *entirely free from bark* and foreign matter.

References

- 1 Varma, B. S. and Dey, A. C.: *Ind. Forest Leaflet*, No. 28, 1942.
- 2 Ramaswami, S. and Dey, A. C.: *Ind. Forest Leaflet* No. 30, 1942.
- 3 Wise, L. E.: *Amer. Chem. Soc. Monograph Series*, No. 97, pp. 434-36.
- 4 Jaeger, J. C.: *Austr. J. Sci.*, 1941, 4, 45.
- 5 *Australian Standard Specifications (Engineering Series)* for wood charcoal for use in gas producers for vehicles and tractors, Manager, Government of India, Press, Delhi, 1942, p. 34; *Queensland Government Producer Gas Committee, Bulletin* No. 5 & 6, 1941; *New South Wales Forestry Commission, Division of Wood Technology, Sydney, Pamphlets* Nos. 2, 4 and 5, 1940; *Automotive Engineering Division, Vacuum Oil Co., Pty. Ltd.*, 1941, p. 60.

RUBBER-LINED EQUIPMENT FOR CHEMICAL INDUSTRIES—PART I

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SELECTION of proper materials for the construction of chemical plant equipment is one of the most important, and often one of the most difficult functions of the chemical engineer. Combining as it does, interrelated problems of economics and technology, it is capable of rigorous solution only after an intensive investigation of an ever-increasing array of materials, both metallic and non-metallic. In most cases of chemical equipment, construction factors other than corrosion-resistance will have to be taken into consideration. Mechanical strength and malleability are essential qualities, but usually first cost is an important factor.

The resistance of rubber to corrosion and abrasion has been very largely made use of in chemical industries. The largest contribution of rubber technology to engineering industry in the last 20 years is the perfection of the bonding of rubber to metal. These rubber linings have been put to rigorous tests, and have been found to protect chemical and mechanical equipment from the twin bogeys of corrosion and abrasion.

In marked contrast with the liveliness which rubber displays in its physical reactions, we find in its chemical reactions a pronounced inertia; and this inertia makes rubber particularly suited to certain engineering applications. A study of the varied uses of rubber as a chemically resistant material will show that its resistance is not only due to its chemical inertia and its peculiar physical properties, but to the fact that it can be suitably combined with a variety of other ingredients. Rubber can be compounded in any manner according to requirements, and these compounds can be securely bonded to structural materials.

Raw or unvulcanized *para* rubber has been used as corrosion-resistant linings in the storage of chemicals, as also for chemical transportation equipment. This practice is still in vogue, but only to a very limited extent. At the present day most of the rubber used in chemical service is vulcanized rubber.

The function of rubber-lining in chemical equipment is protective, and not structural. Such linings are useful only to the extent that they protect equipment from corrosion or abrasion, and also protect the contents from contamination. Structural requirements such as resistance to pressure or vacuum must be taken care of wholly in the design of the vessel to be lined. Wood and concrete tanks and other equipment can be satisfactorily rubber-lined where structural requirements indicate the advisability of such construction.

Rubber may vary in its density or hardness over a range beginning with a soft resilient product, such as rubber bands, upto a very hard and brittle product, such as a rubber comb or battery container. During this progression of physical states a variety of changes occur. Thus, the soft rubber band may have up to 600 per cent. elongation, be resilient, and have a tensile strength of 4,000 lbs. per sq. inch and be useless as a material to withstand abrasion, and it may have a coefficient of expansion seven to nine times that of steel. Hence extreme fluctuations of temperature in a large rubber-lined vessel produces disastrous effects causing cracks in the rubber lining. But hard rubber is more resistant to acids at higher temperatures, and also is more resistant to the gouging action of sharp objects than soft rubber. Therefore, in certain cases hard rubber is preferable to soft rubber. Hard rubber is very resistant to ordinary mineral or vegetable oils, whereas soft rubber is not. In practically all pickling operations small quantities of oil are encountered at the surface of the pickling bath, and there is an increasing tendency to make use of new organic inhibitors which have practically the same effect on rubber as oil. Hence it is necessary to use hard rubber in some form or other for this purpose.

Rubber can withstand an exceptional degree of deformation without permanent effect, but is at the same time tough, and when suitably compounded, it requires the

The resistance of rubber compounds to various chemicals¹ is given below:—

Acids,	Concentration by weight.	Maximum temperature ° F.	Nature of rubber compound.
<i>I. Solutions of Inorganic Acids:</i>			
Arsenic acid	Any concentration	150	{ Soft — Specific. Hard — General.
Carbonic acid	Upto saturation at atmospheric pressure	150	{ Soft or hard — General.
Hypochlorous acid (Chlorine water) ..	Do.	{ 100 150	{ Soft — Specific. Hard — Do.
Fluoboric acid	Any concentration	150	{ Soft or hard — General.
Fluosilicic acid	Do.	150	{ Soft or hard — Do.
Hydrobromic acid	Do.	{ 100 150	{ Soft — Specific. Hard — Do.
Hydrofluoric acid	Upto 50 per cent.	150	{ Soft or hard — General.
Hydrochloric acid	Any concentration	150	{ Soft or hard — Do.
Phosphoric acid	Upto 85 per cent.	150	{ Soft — Specific. Hard — General.
Sulphuric acid	Upto 50 per cent.	150	{ Soft or hard — Do.
Sulphurous acid	Upto saturation at atmospheric pressure	150	Hard — Specific.
<i>II. Solutions of Inorganic Salts and Alkalies:</i>			
Aluminium chloride	Upto saturation	150	{ Soft or hard — General.
Aluminium sulphate	Do. do.	150	{ Soft or hard — Do.
Alums	Do. do.	150	{ Soft or hard — Do.
Ammonium chloride	Do. do.	150	{ Soft or hard — Do.
Ammonium hydroxide	Do. do.	100	{ Hard — Do.
Ammonium persulphate	Do. do.	{ 100 150	{ Soft — Do. Hard — Do.
Ammonium sulphate	Do. do.	150	{ Soft or hard — Do.
Barium sulphide	Do. do.	150	{ Soft or hard — Do.
Calcium bisulphite	Do. do.	150	{ Hard — Specific.
Calcium chloride	Do. do.	150	{ Soft or hard — General.
Calcium hypochlorite	Do. do.	150	{ Soft — Specific. Hard — General.
Sodium hydroxide	Do. do.	150	{ Soft or hard — Do.
Potassium hydroxide	Do. do.	150	{ Soft or hard — Do.
Cupric chloride	Do. do.	150	{ Hard — Do.
Copper cyanide (Alkaline solution) ..	Do. do.	150	{ Soft or hard — Do.
Copper sulphate	Do. do.	150	{ Soft or hard — Do.
Ferric chloride	Do. do.	150	{ Soft — Specific. Hard — General.
Ferrous sulphate	Do. do.	150	{ Soft or hard — Do.
Nickel acetate	Do. do.	150	{ Hard — Specific.
Potassium cuprocyanide	Do. do.	150	{ Soft or hard — General.
Potassium dichromate	Do. do.	150	{ Hard — Do.
Sodium antimonate	Do. do.	150	{ Soft or hard — Do.

Acids.	Concentration by weight.	Maximum temperature ° F.	Nature of rubber compound.
<i>II. Solutions of Inorganic Salts and Alkalies—contd.</i>			
Plating solutions:			
Brass	Upto saturation	150	{ Soft or hard — General.
Cadmium			
Copper			
Gold			
Lead			
Nickel			
Silver			
Tin			
Zinc			
Sodium bisulphite	Do. do.	150	Hard — Do.
Potassium bisulphate	Do. do.	150	{ Soft or hard — Do.
Sodium chloride	Do. do.	150	{ Soft or hard — Do.
Sodium cyanide	Do. do.	150	{ Soft or hard — Do.
Sodium hypochlorite	Do. do.	150	{ Soft — Specific. Hard — General.
Sodium sulphide	Do. do.	150	{ Soft or hard — Do.
Sodium sulphite	Do. do.	150	{ Soft or hard — Do.
Sodium thiosulphate	Do. do.	150	{ Soft or hard — Do.
Silver nitrate	Do. do.	150	Soft — Specific.
Tin chloride	Any aqueous solution	150	Hard — General.
Zinc chloride	Upto saturation	150	{ Soft or hard — Do.
Zinc sulphate	Do. do.	150	{ Soft or hard — Do.
<i>III. Organic Materials:</i>			
Acetic acid	Any concentration	150	Hard — Specific.
Acetic anhydride	Do. do.	150	Hard — Do.
Acetone	Do. do.	150	{ Soft — Do. Hard — General.
Amyl alcohol	Do. do.	150	{ Soft — Specific. Hard — General.
Aniline hydrochloride	Do. do.	150	{ Soft or hard — Do.
Butyl alcohol	Do. do.	150	{ Soft — Specific. Hard — General.
Casein	Do. do.	150	{ Soft or hard — Do.
Castor oil	—	150	Hard — Specific.
Citric acid	Any concentration	150	Soft — Do.
Coconut oil	—	150	Hard — Do.
Cottonseed oil	—	150	Hard — Do.
Dyestuffs	—	150	Hard — Do.
Ethyl alcohol	Any concentration	150	{ Soft — Do. Hard — General.
Ethylene glycol	Do. do.	150	{ Soft or hard — Do.
Formaldehyde	40% aqueous solution	100	Hard — Specific.
Formic acid	Any concentration	100	Hard — Do.
Furfural	—	100	Hard — Do.
Gallic acid	Upto saturation	150	{ Soft or hard — General.
Glucose	Any concentration	150	{ Soft or hard — Do.
Glue	Do. do.	150	{ Soft or hard — Do.
Lactic acid	Do. do.	150	Hard — Specific.
Malic acid	Do. do.	150	{ Soft or hard — Do.
Methyl alcohol	Do. do.	150	{ Soft — Do. Hard — General.

Acids.	Concentration by weight.	Maximum temperature ° F.	Nature of rubber compound.
<i>III. Organic Materials—contd.</i>			
Mineral oils	— —	100	Hard — Specific.
Propyl alcohol	Any concentration	150	{ Soft — Do. Hard — General.
Soaps	Do. do.	150	{ Soft or hard — Do.
Tannic acid	Do. do.	150	{ Soft or hard — Do.
Tartaric acid	Do. do.	150	{ Soft — Specific. Hard — General.
Triethanolamine	Do. do.	150	{ Soft or hard — Do.
Vinegar	— —	150	Hard — Specific.

expenditure of a considerable amount of energy to stretch or compress it. This remarkable extensibility, combined with a tensile strength approaching that of metals, enables rubber to store energy to a degree far greater than that of any known solid material. Closely allied to this energy-storing capacity of rubber is its unique resistance to abrasion, due partly to its inherent cohesion and partly to its ease of deformation. Rubber owes its wide range of applicability to these peculiar properties.

Design Features

Rubber linings can be applied to various structural materials. There are certain instances, however, in which steel is not the logical choice because of considerations of cost, ease of fabrication, adaptability to a wide variety of structural and process requirements, adaptability to requirements for successful application of rubber lining and ease with which repairs and alterations can be made.

An obvious basic design principle in making large equipment to be rubber-lined is that all surfaces to be covered with rubber must be readily accessible to work with hands. The one important exception to this is in the case of pipes, where the lining procedure is different. Rubber-lined metal tanks should be located in such a way that all exterior surfaces are readily accessible for inspection, painting and repairs.

Practically all rubber-lined metal tanks of the present day are of welded steel-plate construction. Modern welding technique has made this method highly economic and adaptable. Because of the comparative smoothness and uniformity of the surfaces, welded construction is the most suitable in the design of rubber-lined equipment. The more important precautions to be observed

in the fabrication of welded tanks for rubber-lining are:

1. Joints over which rubber is to be applied must be solid welded.
2. Porosity in the finished welded article should be avoided.
3. All sharp edges should be rounded off.
4. Corners should be rounded off to an approximate minimum radius of $\frac{1}{8}$ ".
5. Outlets should be made flush with the plate inside; and all outlets must be of flanged type.
6. When screwed flanges are used, they must be peened in place to prevent loosening in service.
7. Tanks for pressure or vacuum service should be tested before lining with rubber. An air-leak in the steel tank will cause failure of the rubber lining if the vessel is used under vacuum.

A safe rule to be followed in the design of equipment to be lined with rubber is to avoid the use of large or complex castings wherever possible. Small and simple castings, like standard fittings and flanges, offer no difficulties.

In the case of rubber-lined pipe installations flanged construction is found to be the most suited. In any long pipe-line, expansion and contraction are a problem. Short lengths of rubber hose can be installed at intervals to take care of these changes, or alternatively, special expansion joints can be specified. A new type of flexible coupling for pipe-lines has recently been made use of, and this is found to be extremely suitable for large rubber-lined pipes in low-pressure or gravity installations. In this construction plain-end steel pipe is lined on the inside, and the rubber is carried back about five inches on the outside at each end. A special ribbed rubber gasket, known as "flexlock," is

slipped over each end of the two adjoining pipe-lengths, and a split-steel rubber-lined sleeve is bolted over the two ends to make a seal. About $\frac{1}{4}$ " of free space is allowed between pipe ends, so that expansion and contraction in long lines are readily absorbed at the joints. The coupling assembly is sufficiently flexible to permit small angularities in the line without special fitting. Similarly, misalignment of pipe lengths can be compensated for within reasonable limits.

Methods of Application of the Rubber Lining

In considering the methods of applying rubber lining to structural materials, two different approaches are to be made according as rubber latex or solid rubber sheet is used for the lining process.

Production of rubber-lined articles starting from rubber latex is of rather recent origin. One great advantage of the linings obtained in this manner is that since rubber latex is not subjected to any degradation process, the elasticity and tensile strength of the resulting rubber is extremely high, values of tensile strength higher than 5,000 lbs. per sq. inch being readily attainable, and an elongation upto 900 per cent. being easily reached. In ageing properties also this rubber is found to be far superior to the ordinary masticated rubber. This difference is due to the fact that during the milling of raw rubber sheet, the physical structure of the rubber undergoes a thorough change due to the disintegration of the rubber molecule. But in the case of latex rubber, the rubber molecule remains intact.

Various processes have been developed and patented for coating articles with rubber latex. The most common methods employed for this purpose are (i) electro-deposition, and (ii) ionic deposition.

Electro Deposition.—The electro-deposition process²⁻¹⁰ is based on the fact that the rubber particles in latex are negatively charged. In an electric field these particles move towards the anode. The behaviour of latex particles⁸ under the influence of an electric field is summarized below:—

Electric field.

1. No current.
2. Field applied unidirectionally.
3. Polarity of field frequently reversed.
4. Field applied unidirectionally.
5. Polarity of field immediately reversed once after deposition.

Work on electro-deposition of rubber has shown that it is possible to admix with latex, sulphur, pigment and other desired ingredients, and then to deposit this rubber compound electrically on materials to form coherent, homogeneous layers of a considerable range of thickness. It has also been observed that the composition of the deposit obtained is more or less the same as that of the bath. Incidentally, it may be mentioned that electro-deposition of rubber from latex has been extended to the production of a large number of rubber goods such as toys, hoses, insulated cables, etc. Wherever applicable, electro-deposition of rubber offers a greater economic advantage over the process of milling, mainly due to the reduction of power and labour charges.

In the electro-deposition process it is highly desirable that a constant rate of deposition be obtained without varying any of the variables, namely, time, current density, conductivity, etc. This is effected by arranging the deposition bath with a porous diaphragm between the latex and the cathode, so that while the rubber particles migrate towards the anode, an electro-endosmotic flow of serum occurs through the porous diaphragm into the cathode compartment. Thus the concentration of the latex bath is kept uniform. The thickness of the deposit obtained varies directly with the current density. It varies also directly with time, and inversely with conductivity of the bath.

Several modifications have been introduced into this simple method of electro-deposition, and most of these are covered by patents¹¹⁻¹⁴.

Although the latex particles are negatively charged, the charge may be reversed under suitable conditions, so that instead of depositing on the anode of an electrolytic cell, the rubber gets deposited on the cathode¹⁵. In order to reverse the charge on the particles, the latex is stabilized by an agent like casein, and acids or acid salts are added until the hydrogen ion concentration of the latex is slightly below pH.7, when the particles assume a positive charge;

Latex behaviour.

- Particles in active Brownian movement.
 Particles move towards anode.
 Direction of movement of particles reversed.
 Particles deposit on anode, and build up multi-particle layer.
 Particles redisperse and move away from the anode.

and if now an electric field is applied these particles will get deposited on the cathode.

The electro-deposition process has been found to be very useful in rubber-coating articles of complicated shapes. The bond obtained between the rubber and the base material is also extremely strong, tensile strengths of the order of 6,000 lbs. per sq. inch being attainable.

Sheet Lining

A large amount of work has been done on the lining of chemical equipment with sheet rubber. Here corrosion-resistant sheets are bonded on to the metal or non-metal base by means of special methods. The use of suitable adhesives is one of the most common methods employed. But the nature of the adhesive varies widely with the nature of the material that is to be lined with rubber. Then, there are a number of patent processes the complete details of which are not available. The "Vulcalock" process¹⁶ developed by the *Goodrich Rubber Company* is an example. This made possible the first steel tank car for hydrochloric acid service. Vulcalock process is one of vulcanization by which soft rubber can be attached to the surface of metals with a strength of adhesion exceeding 500 lbs. per sq. inch. This does not depend on an adhesive, but virtually "locks" the rubber into the pores of the metal base, so that the union is as permanent as the rubber itself.

The coefficient of linear expansion of hard rubber within the temperature range of 32° to 142° F. is 3 to 5 times that of steel. This makes it sometimes hazardous to use large-size steel equipment lined with hard rubber for service where rapid changes in temperature occur. Recognizing certain distinct advantages and limitations in each type of rubber, soft and hard, for chemical service under conditions of variations of temperature, liability of shock, impact or abrasive wear, rubber technologists have evolved a new construction which successfully combines the two types. In this construction, a layer of hard rubber is cushioned between two sheets of soft rubber, with suitably spaced overlapping expansion joints which effectively prevent cracking or buckling of the hard layer under expansion and contraction with temperature changes. This is known as the "Triflex" construction. Soft and hard rubber plies are arranged so that the hard rubber plies are not joined, but overlap each other. These joints absorb

the expansion and contraction of hard rubber, and eliminate buckling and cracking.

Various grades of corrosion- and abrasion-resistant rubber linings are available under different trade names. Some of the well-known linings are Plioweld (manufactured by *Goodyear Rubber Co.*) Ace Rubber Linings (*American Hard Rubber Co.*), Manhattan Rubber Linings (*Manhattan Rubber Manufacturing Co.*), Vulcoferran Linings (*Nordac Co.*), Silvertown Tank Linings (*Silvertown Rubber Co.*), and Dexonite Linings (*Rexine Co.*). These protective linings are specially formulated to meet the demands of the specific industry using them.

Another important branch in the work on corrosion-resistant rubber linings has been the production of rubber derivatives¹⁷⁻²⁷. The chlorinated rubbers²⁸⁻³⁵, in particular, have a considerably improved resistance to many corrosive chemicals. For protecting metal, wood or concrete equipment from atmospheric and chemical deterioration, highly chlorinated rubber is very suitable. Though chlorinated rubber has been known for many years, its successful adaptation to the protection of materials has been accomplished only in recent times. Owing to the low price of rubber and chlorine, and to modern production methods, this type of protective coating can compete with others successfully. Chlorinated rubber is now used for the preparation of corrosion-resistant paints and lacquers, moulding powders, floor-coverings, pipe-joints, etc.

Applications

Corrosion resistance, wear and abrasion-resistance, and insulation against electricity, heat, sound or vibration are all possible through the rubber coating of equipment. The main advantages of rubber linings in chemical industries are:

1. Protection of equipment from corrosion, abrasion or impact,
2. Absorption of shock or vibration,
3. Resilient support of load,
4. Flexible transmission of power, and
5. Sealing of fluids.

Because of this wide range of utility, this particular branch of work has been termed "Elastometric Engineering."

Chemical Industries offer innumerable examples of the use of rubber-lined equipments for process industries³⁶⁻⁴¹.

The hydrochloric acid transport problem which has always been a source of annoyance to the manufacturers and consumers alike,

has been almost completely solved through the use of rubber-lined tank cars or drums. Rubber-lined steel tanks offer a good substitute for wood equipment. The special features of such rubber-lined steel tanks are:

(1) Ease of erection; (2) freedom from buckling or warping; (3) ease of transport; (4) absence of leakage; the tank may be struck or even dented without injury to the lining; (5) elimination of the necessity of pumps, since corrosives may be transported over long distances by application of air pressure.

Rubber-lined steel tanks have been long in use for handling and storing c.p. hydrochloric acid in the production of pure tungsten metal. It has been reported that steel tank cars of 8,000 gallons capacity were used for three years for transporting hydrochloric and phosphoric acids, without any sign of deterioration. Tanks with suitable rubber linings are used for the storage of various other inorganic acids such as arsenic, boric, phosphoric, sulphuric, hydrobromic, hypochlorous, hydrofluoric, etc., and organic acids like benzoic, citric, malic, gallic, oxalic, etc. It is claimed that an ebonitlined vinegar pump installed by the *Silvertown Rubber Company* in 1866 is still in daily use.

Rubber protection has an important place in the rayon industry, where rubber-lined equipments are used in spinning rooms, processing-acid baths and recovery systems.

Electroplating industry uses rubber-lined tanks as containers for the plating bath.

In the steel industry, where sulphuric, muriatic, nitric or hydrofluoric acid may be used as the pickling or cleaning agent, the problem of getting suitable tanks or vats which will withstand the action of these corrosives has always been one of great importance. After elaborate work on rubber compounding, the *Goodrich engineers* have demonstrated convincingly that combinations of hard and soft rubber are the ultimate solution to the perplexing problem of providing containers for pickling agents.

Rubber-lined reaction chambers, adsorption, settling and filter tanks are used in the production of hydrofluosilicic acid; rubber-lined mixing tanks are used in the manufacture of commercial bleach; rubber-lined adsorption towers are used for gaseous reactions; rubber-lined filter tanks handle effluent in pigment precipitation.

Rubber has helped to overcome abrasion in many types of equipment⁴¹⁻⁴⁴. The abrasion-resistance of properly compounded and cured rubber has been strikingly demonstrated in the displacement of sheet steel as a re-liner of chutes used for highly abrasive materials such as sand, gravel, crushed rock, ore, coal, etc. Rubber linings outlast steel by a large margin, and the saving in operating cost is considerable. The use of rubber linings in grinding mills can be illustrated by a numerical example. A mill in a cement plant was charged with 45,000 lbs. of steel balls. The dimensions of the mill were 22' x 5', and it was lined with rubber sheet to a thickness of 1". After ninety days of continuous operation, inspection of the lining showed that the cloth imprint on its surface was not removed. After 14 months of continuous operation a wear of 1.64" was observed.

The impeller of a dust pump with a speed of 3,400 r.p.m. working for 16 hours a day was found to wear out in one month. But when lined with rubber, the life of the impeller was extended to three months.

Specially compounded abrasion-resistant rubber is used in rubber rollers for industrial plants, especially for wringer and scrubber roller service in sheet steel mill, galvanizing plants, paper mill, sheet glass plants, and in many other industries. The high-grade rubber used in these rollers results in exceptionally economical service under severe operating conditions.

A wet vibrating screen was lined with rubber and this increased its life to 2,847 hours as compared to 212 hours of a non-rubber lined screen, handling 84,424 tons in all.

Fan blades used in the suction-exhausting of ashes had their usual length of service extended by 500 per cent. through rubber lining.

An interesting test was performed by a mechanic on the mechanical strength of a rubber-lined valve. A valve of this type was opened and closed every 28 minutes for 60 working days, making a total of 2,000 compressions on rubber. There was no cracking and no sign of wear.

Limitations

In many industrial processes rubber-lined vessels are subjected to chemical or solvent action or temperature conditions. When conditions of service are known beforehand, the rubber can be compounded to meet specific demands.

The outstanding exceptions to the general chemical inertia displayed by properly compounded rubber towards corrosives are nitric, chromic and concentrated sulphuric acids, and the dry halogens. In the organic field it is found that rubber is swollen, deteriorated and adversely affected by oils and aromatic solvents. The deterioration of rubber is particularly marked in the case of solvents like benzene, carbon tetrachloride, and carbon disulphide. Mineral oils and greases seriously affect most of the different grades of soft rubber, but a very good degree of resistance is observed in the case of specially prepared hard rubbers. Great strides have recently been made in compounding rubber to resist the action of oils, fats, greases and organic solvents. In fact, rubber linings having a high degree of resistance to oils and solvents are now available.

Another limitation to the application of rubber in chemical industries is that above 150° F., the effects of oxidation, diffusion and absorption become aggravated, and consequently the life of the rubber products is appreciably shortened.

In spite of these few limitations, rubber remains unique as an abrasion and corrosion-resistant material.

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References

- 1 *Chem. Met. Eng.*, 1932, **39**, 264.
- 2 *Brit. Pat.*, 223,188.

- 3 *U. S. Pat.*, 1,548,689.
- 4 *U. S. Pat.*, 1,476,374.
- 5 *Chem. Met. Eng.*, 1934, **41**, 367.
- 6 *Ind. Eng. Chem.*, 1933, **25**, 609.
- 7 *Ibid.*, 1938, **30**, 1282.
- 8 *Trans. Amer. Electrochem. Soc.*, 1927, **52**, 47.
- 9 *J. Inst. Elect. Eng.*, 1939, **75**, 481.
- 10 *India Rubber World*, 1926, **83**, 193.
- 11 *Brit. Pat.* 245177.
- 12 *U. S. Pat.*, 1702705.
- 13 *Brit. Pat.*, 296138.
- 14 *Brit. Pat.*, 325401.
- 15 *Ind. Eng. Chem.*, 1932, **24**, 762.
- 16 *U. S. Pat.*, 1617588.
- 17 *Helv. Chim. Acta*, 1926, **9**, 549.
- 18 *Ind. Eng. Chem.* 1927, **19**, 1325.
- 19 *U. S. Pat.*, 1705757.
- 20 *U. S. Pat.*, 1852345.
- 21 *U. S. Pat.*, 1642018.
- 22 *Ind. Eng. Chem.*, 1927, **19**, 1033.
- 23 *Brit. Pat.*, 306390.
- 24 *Brit. Pat.*, 347108.
- 25 *U. S. Pat.*, 1890924.
- 26 *German Pat.*, 549759.
- 27 *Brit. Pat.*, 382755.
- 28 *Chem. Met. Eng.*, 1939, **46**, 456.
- 29 *J. Soc. Chem. Ind.*, 1938, **57**, 327.
- 30 *Gummi-Ztg.*, 1939, 497.
- 31 *Ind. Eng. Chem.*, 1934, **12**, 179.
- 32 *Oil and Colour Trades J.*, 1935, **88**, 1251.
- 33 *Brit. Pat.*, 2734.
- 34 *Brit. Pat.*, 2762.
- 35 *Brit. Pat.*, 121091.
- 36 *Chem. Met. Eng.*, 1938, **45**, 611.
- 37 *Ibid.*, 1931, **38**, 396.
- 38 *Ind. Eng. Chem.*, 1939, **25**, 609.
- 39 *Gummi-Ztg.*, 1932, 497.
- 40 *Chem. Met. Eng.*, 1932, **39**, 99.
- 41 *Ibid.*, 1926, **33**, 627.
- 42 *Ibid.*, 1933, **40**, 467.
- 43 *Ind. Eng. Chem.*, 1931, **23**, 462.
- 44 *Ibid.*, 1927, **19**, 139.

Obituary

Dr. R. K. PILLAI, B.A., PH.D. (CANTAB.)

THE sudden and premature death of Dr. R. K. Pillai on 5th May 1946, as a result of a motor accident, has removed from our midst a popular colleague and a brilliant research worker. Dr. Pillai was the son of Mr. R. Eswaram Pillai, a famous Malayalam scholar and writer. Mr. Pillai had a bright academic career and after taking the B.A. Degree of the Madras University at the early age of twenty, he joined the staff of the Agricultural College, Coimbatore, and interested himself in Agricultural Chemistry with special reference to animal nutrition. In 1935, he proceeded to Cambridge for higher studies in Biochemistry and worked in the Cambridge Biochemical Laboratory with Dr. Joseph Needham. The

results of his researches on muscle metabolism have been published in a series of three important papers, viz., *Coupled esterification of phosphate*, *Phosphorylations and dephosphorylations*, and *The action of arsenate in glycolysis*. This work brought him the Ph.D. Degree of the Cambridge University (1938). In the subsequent year, he was elected to Bum W. Levy Research studentship. Dr. R. K. Pillai joined the *Council of Scientific and Industrial Research* in 1943 and was actively engaged in various academic and industrial problems. Shy and silent by nature, he commanded the respect of his colleagues by his unassuming manners, deep knowledge and conscientious work.

WORKS CONTROL LABORATORY FOR GLASS AND CERAMIC FACTORIES IN INDIA

By ATMA RAM and Y. P. VARSHNEY

(*Central Glass and Ceramic Research Institute, Jadavpur, Calcutta.*)

THE stoppage of imports of glass and ceramic articles during the war years led to a considerable expansion of the glass and ceramic industries in India and the domestic production was able to meet most of the requirements of the country. With the return of normal times, or, to put it in trade language, with the removal of this artificial protection, Indian products will have to compete in the open market. It will not be denied that there is a great need for improving the quality and for maintaining uniformity in production and the future of the glass and ceramic industry in India will be determined largely by the extent to which scientific methods will be adopted in production practice.

The industries have realized the importance of scientific control, but with few exceptions, control laboratories have not been started in glass and ceramic factories. Operations are carried on with rather scanty knowledge of the raw materials employed. Defects in manufacture can be ultimately traced to the poor quality and non-uniformity of the starting materials and the importance of evaluating precisely the quality of the raw materials cannot be overemphasized. Sending one or two samples of these materials or the finished products to testing laboratories and obtaining their reports does not help. Industrial production is a continuous process and no central laboratory, however well-equipped and organized, can render effective and timely assistance to a large number of widely distributed factories.

One of the essential requirements is that factories should employ technically trained staff. This is being gradually recognized and adopted, but in order that the knowledge of such technical personnel is properly utilized, it is necessary to provide them the facilities of properly equipped control laboratories.

Such laboratories are not generally expected to develop into research centres, though those attached to larger works may do so in course of time. There are numerous ways in which they can materially assist the day-to-day production of the factory. For instance, a close check on the raw materials

is necessary to maintain a uniform quality of production. A close watch has to be kept on articles produced by frequent testing. In the glass and ceramic industries, the examination of defects in the ware often leads to valuable information regarding faults in processing; and if such defects can be diagnosed as soon as they crop up, preventive or remedial steps can be taken to ensure improved production. Such measures lead to higher percentages of good quality, saleable goods and immediate returns.

Under the charge of capable scientific workers, such laboratory units can be made to yield returns far greater than the initial outlay or recurring expenditure incurred on them. For special problems, which are beyond the scope of small control laboratories, assistance will have to be taken from research centres like the *Central Glass and Ceramic Research Institute*, and here again, the work of the control laboratory will be of value as it will provide the central institute with the technical data necessary for the solution of the problems. Moreover, the translation of results of research investigations to successful works practice requires the assistance of technical workers and control laboratories.

The writers have received a number of inquiries from factories asking for advice in setting up laboratory units in the works. It would appear that there is a widespread appreciation of the need for such a laboratory. This note on the design and equipment of a works laboratory has been prepared to meet the general requirements of Indian glass and ceramic factories.

The laboratory will be adequate for carrying out investigations of the following nature:

- (a) Examination and chemical analysis of raw materials.
- (b) Chemical analysis of glass and ceramic products.
- (c) General testing and examination of finished ware.
- (d) Small-scale trials with compositions for glasses or ceramic bodies and glazes, etc.

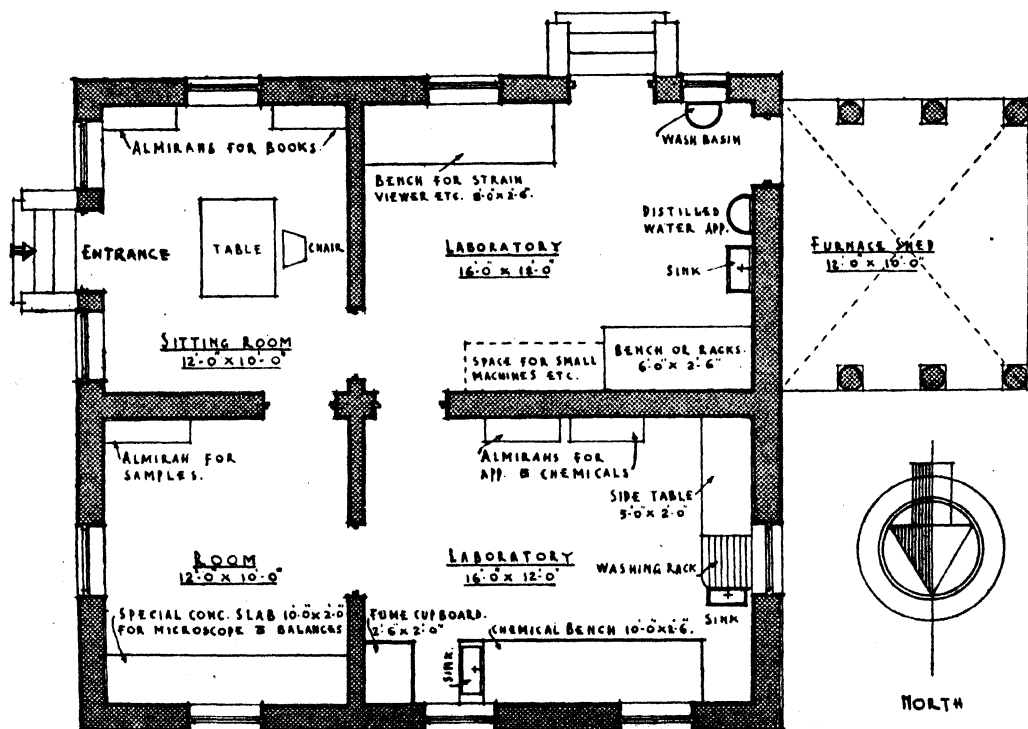
A plan for the laboratory is suggested, and the instruments and general equipment required are shown in Appendix 1. Chemicals and apparatus required for routine chemical analysis can be obtained from any of the reputed dealers in laboratory apparatus and chemicals*. The suggestions are not to be taken too rigidly. For instance, if a factory has already got sufficient accommodation for a laboratory, or if for some reason a different plan is more practicable and advantageous, there is no particular reason why the arrangement of rooms shown in the plan given here should be adopted. Similarly, the size of the rooms and the floor areas given in the plan are only illustrative. Where it is desired to have a laboratory with a wider scope, an appropriate addition in floor space, equipment and apparatus can be made.

*Reprints of this article with lists of laboratory apparatus and chemicals, can be had from the Officer-in-charge, Central Glass and Ceramic Research Institute, Jadavpur, Calcutta, against payment of annas eight per copy.

With regard to services, viz., electricity, gas and water, conditions vary largely from place to place, but in view of the fact that in many factories gas is not available, alternative heating apparatus and experimental furnaces have been proposed. Where gas is available certain items can be replaced, and if electricity is available at reasonable rates, the units can be replaced by electrically heated ones.

With few exceptions, all the factories have water pipes laid. In any case, in order to ensure water-supply under sufficient pressure in the laboratory taps, it is recommended that a water-fed reservoir of at least 500 gallons capacity be placed either on the roof of the laboratory building, or on some other suitable structure at a height of about 20' to 25' (or more if possible) above the laboratory floor.

The work of examination and evaluation of raw materials and the chemical analysis of finished products are of the same nature in glass as well as in ceramic factories, and



Plan of Laboratory.

practically the same equipment is required. So is the case with microscopic examination, and even in laboratory furnaces very little variation is necessary. However, the general testing procedure (though in a small laboratory of this type only a few simple tests can be conducted), varies with the nature of articles made by the factory. The special requirements of glass and ceramic factories are indicated in Appendix I.

It is difficult to estimate with any accuracy the initial outlay on such a laboratory; it will vary from place to place, and according to circumstances, but under prevailing conditions in Calcutta, it is expected to be about Rs. 18,000, made up as follows:—

	Rs.
Buildings	5,000
Benches, furniture and water, gas and electric fittings .. .	4,500
Instruments, apparatus and chemicals .. .	7,000
Miscellaneous .. .	500
Total .. Rs.	18,000

The annual recurring expenditure, on the basis that one trained scientist normally works in the laboratory, will be about Rs. 4,500—Rs. 3,100 being the salary of the staff, and Rs. 1,400, cost of chemicals, gas, etc.

The writers desire to thank *Messrs. Ballardie Thompson and Matthews*, Architects, Calcutta, for help in preparing the plan.

APPENDIX I.

Testing Instruments and other Apparatus

Equipment under this list has been divided into three groups: Group I, "general," for both glass and ceramic factory laboratories, Group II, for glass factory laboratories only, and Group III for ceramic factory laboratories only.

Group I.

Counter scales and weight box—1 kgm.
Triple lens magnifying glass.
Hygrometer.
Autoclave (approx. 15" dia. x 18" high) for pressures up to 30 lbs./sq. in.
Horse shoe magnet.
Nest of sieves (*I.M.M.* or *B.S.S.*) comprising 12 sieves of 10, 20, 30, 40, 50, 60, 70, 80, 100, 120, 150 and 200 mesh.
Orsat gas analysis apparatus (3 bulbs).
Medium power microscope (Petrographic).
Simple apparatus for section making (cutting and polishing).
Slide glasses and slide box.
 $\frac{1}{2}$ lb. or 1 lb. capacity fireclay crucibles.

Platinum-Platinum-Rhodium thermocouple with compensating leads and temperature indicator, or alternatively Portable type Optical Pyrometer for higher temperatures and one base metal thermocouple with indicator for lower temperature measurements.

Laboratory muffle furnace—size of muffle being about 18" x 10" x 8". (This may be gas-fired, oil-fired or coal-fired according to circumstances. In case an electrically heated unit is employed, size of the muffle may be smaller.)

Group II.

Strain viewer.

Laboratory high temperature furnace for making experimental meltings. This should be capable of holding one or more fireclay crucibles of $\frac{1}{2}$ lb. or 1 lb. capacity, and may be electrically heated, gas-fired or oil-fired. In the case of gas heating, a Fletcher type injector furnace unit may be used.

For bottle making factories, it is often necessary to test bottles for thermal shocks and bursting pressure. For simple thermal shock tests, two water cisterns (each about 3' x 2' x 1 $\frac{1}{2}$ ' deep) one for hot water, preferably with a steam heating coil, and the other for cold water, are required. In addition, a few portable racks, each capable of holding 12 to 18 bottles in upright position, will be needed. For the second test, a hydraulic bursting pressure testing machine will be needed.

Group III.

Briquette making moulds.

Cathetometer or low power travelling microscope.

Seger cones (assorted of various numbers).

Laboratory ball mill (hand-driven or power-driven).

Laboratory sample grinder (hand-driven or power-driven).

Laboratory high temperature furnace. The size and type of this unit will depend upon individual requirements of the ceramic factory.

Note 1: For gas or oil heated high temperature furnaces in groups II and III, air supply under pressure, either from a power-driven compressor or blower will be required.

Note 2: In estimating the total initial cost of the laboratory high temperature furnace units suggested in groups II and III have not been included as the cost of these vary very widely.

APPENDIX II.

Personnel

The minimum requirements of staff for such a laboratory are considered to be one chemist, one laboratory assistant and one bearer. Although their salaries may vary from place to place and even with the nature of the duties at the works, their emoluments should not be lower than those given below:

	Per mensem
Chemist	Rs. 200
Laboratory Assistant .. .	Rs. 40
Bearer .. .	Rs. 20

On this basis, the annual expenditure on staff will amount to about Rs. 3,100.

FURTHER DEVELOPMENTS IN THE ALUMINIUM INDUSTRY IN INDIA

By KENNETH HALL

(*Indian Aluminium Company Ltd., Calcutta*)

IN a previous article which appeared in the July, 1943 issue of this *Journal*, the writer traced the history of the aluminium industry in India and gave a brief outline of the progress and war-time developments of the industry to that date. The purpose of this present article is to attempt to outline the further progress in the aluminium industry which have taken place during the past two and a half years, and also to give some picture of probable post-war developments.

Throughout the war, and particularly during the critical years following on the entry of Japan into the war, the aluminium industry was able to make a very substantial contribution to the war effort. From early 1943 onwards, the whole of India's war-time requirements of aluminium were supplied from the *Aluminium Reduction Works* at Alupuram, Travancore State, during a period when it would have been impossible to obtain supplies of aluminium from any outside source. Rolling mills and manufacturing plants were also fully mobilized in the war effort, and produced sheet and components for the manufacture of aircraft parts, radio and field telephone equipment, range finders, binoculars, field hospital equipment, mess tins, etc. During the last two years of the war, many thousands of long-range fuel tanks were manufactured for use by fighter aircraft in the Burma Campaign, from aluminium produced at Alupuram and rolled into sheet at Belur, Calcutta; the actual fabrication of these tanks being carried out by *Aluminium Manufacturing Co., Ltd., Jeewanlal (1929) Limited*, and *Hindustan Aircraft Ltd.*

The year 1943 saw aluminium produced for the first time in India at the Alupuram Reduction Works of *Indian Aluminium Company, Ltd.* in Travancore State, and the production of aluminium has since continued on a steady commercial basis. It is of interest to note that from a technical viewpoint, operations at these Works compare very favourably with those of the larger producers in Canada and the United States. A further development in the operation of these Works

has been the starting up of the electrode plant, which for a considerable period has been successfully manufacturing carbon electrodes for the production of aluminium from Indian raw materials. Output of the Reduction Works has hitherto been limited by war-time restrictions upon the amount of power which could be made available for their operation, but additions now in hand to the Travancore State Hydro-electric Scheme will result in an appreciable increase in output during the present year, while completion of this expansion will result in the output of the Works being brought up to their full projected figure of 5,000 tons per year.

During the past two and a half years, the Rolling Mills at Belur, Calcutta, have been wholly and successfully engaged in the production of aluminium sheet to rigid chemical and physical specifications for use in aircraft. However, approximately a year ago steps were taken at the request of Government to expand these Rolling Mills and to install the necessary equipment for the production of strong alloys of the Duralumin type. This expansion has now taken place, and the necessary equipment, including additional rolling mills, heat treatment furnace, etc., has been received. In view of the importance of the strong alloys of aluminium in industrial applications and in the field of transportation, this particular development, which is being actively proceeded with, is of special importance in India, where little has hitherto been known of the applications of the alloys of aluminium. Concurrently with this, construction has recently been completed of the metallurgical laboratory building, which will house under one roof complete facilities for chemical analysis, physical testing, and microscopic and macroscopic control and research, upon which quality of the product depends.

Construction is now well advanced of an Alumina Works on a site of some 180 acres at Muri Junction, Bihar, for the treatment of Indian bauxite. These Works are expected to go into operation towards

the end of the present year, and will have an initial capacity of 10,000 tons and an ultimate capacity of 40,000 tons of alumina per year. In their design, they embody a very considerable advance in technique resulting from war-time experience abroad in the treatment on a large scale of various grades of bauxite. Initially these Works will utilize bauxite from the Ranchi District of Bihar, where modern mechanical mining and conveying equipment will be installed at the bauxite mines.

In these developments, the important question of personnel has not been lost sight of. Taking advantage of facilities for passage given by the Government of India, a number of Indian technicians from all the above Works are now undergoing courses of training at various aluminium plants in Canada, and will return to fill responsible technical positions in the aluminium industry in India.

During the past two years, the Alumina Works and Reduction Works of the *Aluminium Corporation of India Ltd.*, located at Asansol, Bengal, have also started operations. After the arrival, at the request of the Government of India, of technical experts from Canada, the Alumina Works were brought into production in May, 1944, drawing their supplies of bauxite from the Central Provinces. Following on this, the Reduction Works began operations in July, 1945, and are currently producing aluminium ingot at the rate of approximately 1,000 tons per year. The rolling of sheet has also been carried out on an experimental basis, as well as the production of castings.

While further development was difficult in the circumstances obtaining during the war, as a result of the war-time demand for aluminium sheet several rolling mills came into existence in manufacturing centres such as Calcutta, Bombay and Madras. For the most part, these mills have rolled both brass and aluminium according to the demand, and much of the equipment was necessarily improvised, but they represent an appreciable addition to the aluminium fabricating capacity in this country, and modernization and expansion may be expected as equipment becomes available from abroad. Other immediate post-war developments include the manufacture of aluminium cable, paint and foil. Plans have been completed and equipment is being ordered for the installation of a Works in South India for the production of

aluminium cable for electric transmission lines. Another firm has taken steps to erect a Works for the manufacture of aluminium paint by a patented process. Mills formerly used for the rolling of lead are now being converted to the rolling of aluminium foil for tea chest linings and for packaging. The post-war expansion scheme of another firm includes the installation of a modern aluminium foundry, handling sand, gravity and pressure die castings.

Due to higher standards of living in India, coupled with demands from countries formerly in enemy occupation, which have been stripped bare of all forms of aluminium, consumption of aluminium for general purposes, such as household utensils, is likely to remain substantially higher than before the war. These outlets represent a foundation upon which plans for further development can be superimposed.

Further expansion of the production of aluminium in India is necessarily linked up with increases in the supply of electric power, and this expansion cannot safely be planned until definite information is forthcoming as to what sources of electric power will become available, at what date and at what cost. However, the materialization of several of the power schemes now projected as part of post-war planning should result in a wider scope for the aluminium industry, and in the wider utilization of the various bauxite deposits which are known to exist in India. During the past twenty-five years, the greatest expansion of the uses of aluminium in other countries has been in the fields of transportation and engineering. Plans have already been laid for the establishment of an automobile industry in India, and a substantial consumption of aluminium may eventually be looked for from this source. Shipbuilding is also a fertile field for the use of aluminium, and it is of interest to note that in the United States construction of two 10,000-ton steamers, built entirely of aluminium, has been decided upon. Other industrial uses which may be foreseen in India are in the construction of textile machinery and machine tools, and in equipment for chemical plants, distilleries and the manufacture of paints. That as a result of the war India is becoming aluminium-minded is shown by the recent decision of the Railway Board to construct a number of aluminium passenger coaches as an experimental measure.

Since aluminium is the only non-ferrous metal of which, so far as is known at present, India possesses large deposits, judged by world standards, emphasis will undoubtedly be placed in any post-war planning on the development of these resources as far as possible. Power schemes now projected in various Provinces and Indian States will open up new sources of electric power,

while simultaneously providing an outlet for the metal in the form of transmission lines. Further expansion of the aluminium industry in the post-war period may, therefore, be expected to take place both in the production of the metal, and also in the provision of additional facilities for fabrication, more particularly in those forms which find an industrial application.

PYRITE IN INDIA

By (the late) Dr. E. L. G. CLEGG

(Geological Survey of India)

ALTHOUGH there are several small occurrences of pyrite in India, only two have prospects of being workable, but even these could sustain only a relatively small sulphuric acid industry.

Bihar

Shahabad District.—Am Jhor (Amjhora) 3 miles n.n.w. of Ranjari railway station on the Dehi-Rohtas Light Railway. According to the information available (in 1941), a horizontal bed of pyrite 18"—36" in thickness (averaging 2') is exposed for 157' along the cliff face in a north-east—south-west direction and by a quarry and drift for 78' in a westward direction. The average grade is 35-40 per cent. sulphur. The reserves available are not known, but assuming maximum limits of only 500' by 500', the reserves amount to 55,000 tons with 50 per cent. ore extraction.*

Up to 1941, 700 tons of ore had been mined. The owners are the *Kuchwar Lime and Stone Co.*

Punjab Hill States

Keonthal State.—In Keonthal State, east of Tara Devi to the south of Simla, several seams of pyrite in slates are scattered over an area of about one square mile, and are known as the *Mulraj Pyrites Mines*. The seams are lenticular and vary rapidly in thickness. Mining entails much dead work,

as about 5' of overburden has to be removed to get the ore. The ore, as now despatched to Tara Devi railway station, contains much slate. Picked specimens yielded upto 50 per cent. sulphur but the average sulphur content of the material despatched to the railway station ranges between 35 and 45 per cent. There is about 0.02 per cent. As_2O_3 .

The minimum mining costs would be about Rs. 10 per ton of ore. During 1941 and 1942, 914.5 tons of pyrite were raised and were utilized mainly in the manufacture of sulphuric acid at Agra.

Punjab States.—In the same area as the Mulraj mines, pyrite has been reported to occur in Patiala State near Tara Devi. The occurrence is said to be promising, but has not been investigated. *Messrs. Shambu Nath & Sons, Ltd.*, are interested in the deposit.

Madras

Malabar District.—In the Pandalur ($11^{\circ} 29'$: $76^{\circ} 21'$)—Devala ($11^{\circ} 28'$: $76^{\circ} 23'$)—Nadghani ($11^{\circ} 28'$: $76^{\circ} 25'$) region, iron pyrite is frequently found associated with gold. Rich occurrences of such pyrite have been noted at Nadghani, Harewood, Richmond and Rosedale Mines. It is reported that some pyrite which is now obtained as a by-product in gold mining, is utilized by the *Mettur Chemical and Industrial Corporation Limited*, to manufacture sulphuric acid, after slight concentration of the ore. The sulphur content of the pyrite is about 50 per cent. with a trace of arsenic. The reserves of the deposits are not known; evidently they can only be worked along with the extraction of gold.

*Since the submission of the note by the late Dr. Clegg, geophysical investigations by the Self Potential Method were carried out by the *Geological Survey of India* during 1945-46 to obtain, if possible, a more accurate estimate of the ore reserves. The results obtained so far are, however, inconclusive.

WOOD DISTILLATION AT BHADRAVATI*

By P. R. BALAKRISHNAN

(The Mysore Iron and Steel Works, Bhadravati)

WITH the rapid growth of the coal-tar dye industry in the last decades of the nineteenth century, there arose a heavy demand for acetic acid and wood alcohol. This led to considerable enlargement and improvement of processes and plants for the manufacture of these products. The large modern steel oven with a capacity nearly ten times that of the cast iron retort or about 20 tons of wood per charge came into vogue. Refinements in condensing equipment and in the apparatus for economic and efficient recovery of the volatile products also followed and the wood distillation came to be technically a highly developed chemical industry, continuously striving to improve itself. Efforts in the latter direction have been redoubled since the last World War on account of the competition encountered from new sources and processes for the products developed under the stimulus of the war. The United States of America is the leading country in the field of distillation products. The industry has also attained considerable proportions in Canada. Sweden, France, Germany, Austria and Czechoslovakia have all modern well-equipped plants. England and Japan have also a few small plants. Australia has also established a few up-to-date wood distillation plants. The Bhadravati plant is the only one of its kind in India and is probably the biggest in the East.

Two Branches of Wood Distillation

There are two distinct branches of wood distillation, hard-wood distillation and soft-wood distillation. From the distiller's point of view, hard and soft woods are not distinguished so much by the physical characteristics these terms connote, as by their composition. Woods rich in resinous matter are termed soft-woods, and those containing little or no resinous matter are termed hard-woods. Soft-woods generally give only half as much acetic acid and alcohol as the hard-woods and are more valued for the turpentine, tar and oils they yield. The process of distillation followed in each case

is also different. We are concerned only with hard-wood distillation as the woods used in the Bhadravati plant come under this category, though unfortunately they are not as rich in acetic acid and alcohol as the American or Continental hard-woods.

The following well-known species of Mysore hard-woods are used for conversion into charcoal in the retorts:—

Vernacular name.	Botanical name.
Dindiga	<i>Anogeissus latifolia.</i>
Nandi	<i>Lagerstrania lanceolata.</i>
Honne	<i>Pterocarpus marsupium.</i>
Matti	<i>Terminalia tomentosa.</i>
Jambe	<i>Xylia dolabriformis.</i>
Hunal	<i>Terminalia paniculata.</i>
Yettyaga	<i>Zanthoxylus permum.</i>
Thadasal	<i>Grevia kiliacfolia.</i>
Jalari	<i>Shorea telura.</i>

The average yield of charcoal varies from 25 to 30 per cent. and the average analysis of charcoal is as follows:—

	Per cent.
Moisture	2—4
Ash	4—6
Volatile matter (excluding moisture) ..	18—24
Fixed carbon	70—80

The Retorts

In the *Mysore Iron and Steel Works, Bhadravati*, there are 16 retorts set in 8 pairs or batteries as they are called. Normally 15 retorts can be in operation while one will be down for repairs, cleaning, etc. Each retort holds four buggies of hard-wood weighing about 18 to 20 tons. The retorts are enclosed in brickwork furnaces and are heated by the circulation of hot gases formed by burning waste wood and twigs in the furnaces. Each retort is provided with two copper tubular condensers with a recording thermometer attached to each to mark the temperature of the vapours entering the condensers. As the temperature of the retort rises, most of the water in the wood is driven off, and gradually the wood begins to decompose, giving traces of acetic acid. When the temperature of the vapours rises above 200° C., traces of tar appear and the

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor, *Dictionary of Economic Products and Industrial Resources of India*, 20, Pusa Road, New Delhi.

decomposition becomes vigorous, both the vapours and the condensate increasing in volume. At this stage, known as the exothermic stage, considerable quantities of heat are evolved by the decomposing charge of wood itself. Hence if the external supply of heat is not controlled, the temperature of the vapours rises too rapidly and the reaction gets out of control, resulting in serious loss of products and sometimes causing explosions. Hence in practice this stage is carefully watched for, and the retort firing is regulated such that there is only a very gentle rise of temperature between the range of 230° and 280° C. This range is covered by at least half the period of the distillation, viz., 12 hours. When the reaction shows signs of abating, as can be judged from the fall in the flow of the liquor, the temperature is further raised to 330° or 360° C. to complete the reaction and improve the quality of the charcoal. A portion of the vapours that are evolved during the decomposition of wood is non-condensable and, therefore, issues as gas from the condensers. It contains combustible gases like carbon-monoxide, hydrogen, hydro-carbons and is, therefore, burnt as fuel under the retorts. The liquid that flows from the condensers passes into a central collecting tank and is thence pumped to the chemical plant (still house) for further processing. The carbonization of each charge is completed in 24-36 hours. The hot charcoal from the retorts is then transferred to air-tight coolers where it remains for about 48-64 hours. The charcoal is given an airing in an open shed and is then issued to the blast furnace.

The average amount of wood that can be carbonized per day is 200 tons on 36 hours cycle. They yield about 60 tons of charcoal and 20,000 to 22,000 gallons of pyroligneous liquor. On a 24-hour cycle the production can be increased 50 per cent.

The liquor contains about 3 per cent. of tar in suspension, an equal amount in solution, about 4 to 5 per cent. of acetic acid and about 3 per cent. of alcohol, the rest 80 to 85 per cent. consisting mostly of water and other impurities.

The main product from the carbonization of the hard-woods is charcoal. The calorific values of the various kinds of charcoal range from 6,200 to 7,500 calories. But since the charcoal is used in the blast furnace for smelting ores, for the manufacture of ferro-silicon, calcium carbide and for pro-

duction of producer gas for internal combustion engines, especially motor vehicles in place of petrol in the State, the different kinds of charcoal are valued not merely on their calorific values but also on their mechanical strength and low ash content.

Soft-woods are not carbonized since their charcoal is too brittle for metallurgical purposes.

Charcoal Briquettes

The charcoal is screened before it is used. The braize or dust that is collected is pulverized, mixed with suitable proportions of tar, saw-dust and lime dust and pressed into the required shapes. The raw briquettes are then hardened by heat-treatment in a drying oven and used as fuel for firing the boilers or loco. Some charcoal brize is used in gas producers for generating the gas required to heat pipe moulds in the pipe foundry.

The Chemical Plant

In the chemical plant the tar in suspension is separated from the pyroligneous liquor by allowing it to settle in wooden tanks. The tar collects at the bottom of the tank and is drawn off. The tar so obtained is called the "settled tar." It is distilled in the tar plant to give oils and pitch.

The supernatant liquor is distilled in copper, vacuum evaporators to remove the tar in solution. The tar being comparatively non-volatile remains behind in the still while the other ingredients pass over as vapour and are condensed. The tar thus obtained is known as the "dissolved tar." It differs in composition from the "settled tar" and is not so useful a product. It is freed from acid and is burnt as a fuel under the boilers in the plant.

The distillate from the copper evaporators is allowed to settle in wooden settling tanks to remove traces of oil and is then neutralized with slaked lime to convert the acetic acid into lime acetate. The neutralized liquor is subjected to fractional distillation in a column-still to separate the alcohol and leave behind a dilute solution of lime acetate. This solution is finally evaporated to dryness, partly in vacuum evaporators and partly by means of a drum dryer and an endless chain dryer to yield the solid lime acetate. The acetate is commercially known as "grey acetate of lime" and tests 80 per cent. pure.

The Alcohol Refinery

The alcohol obtained, as mentioned above, is known as "crude wood alcohol" or "crude methanol." It contains about 75 per cent. of pure alcohol, about 15 per cent. acetone and about 10 per cent. of water and oils. It is brownish in colour. It is refined in the alcohol refinery to yield a commercially pure methanol which is water-white and contains 99.5 per cent. of methanol and less than 0.1 per cent. of acetone. The purification is effected by refractionating the alcohol after treatment with caustic soda and sulphuric acid to remove resinous and other impurities. Acetone boils at a lower temperature than alcohol and passes off as a first fraction. But, owing to its forming a constant boiling mixture with the alcohol, it cannot be completely freed from it by simple distillation alone. Therefore, it comes off as a mixture with alcohol which is known as methyl acetone, and contains 50-55 per cent. of acetone. The later fraction is *C.P.* methanol. The last fractions containing allyl compounds are used to make the "denaturing grade methanol."

About 12,000 lbs. exhaust steam (6 to 8 lbs. pressure) and 2,000 lbs. of live steam (150 lbs. pressure) are required every hour for the manufacture of the by-products. The refining of alcohol takes about 3,000 lbs. of live steam per hour. The power consumption by the various pumps and the drying machinery amounts to about 1,000 kwh. per day. The cooling water used for condensers both at the retorts and the still house amounts to about 3 million gallons per day.

The Tar Plant

The settled tar is distilled in the tar plant to make oils and pitch. The tar is heated in steel stills provided with copper condensers. The first fraction consists of acid liquor held in solution by the tar and of oils lighter than water, distilling below about 195° C. The second fraction is known as "heavy oil" being heavier than water and distils between 193° and 235° C. Pitch is left behind in the still in a molten condition. The light oil is a good solvent for the pitch and is used with it for making black paint. The heavy oil is redistilled, to remove traces of acid and light oil and is then supplied as "wood preserving oil" or "creosote oil" to the wood creosoting plant that is run by the Government Forest Department.

A disinfectant named "Kreso" is also made in the tar plant. The oil known as

"Neutral Oil" obtained during the separation of the crude alcohol from the pyroligneous liquor supplies the active ingredient for the disinfectant. The oil is distilled, the fraction rich in phenolic content is separated and is converted into the disinfectant.

Yields

The yield of by-products per day when worked at full capacity is approximately as follows:—

<i>Finished products</i>		<i>Intermediate products</i>
		<i>Still House</i>
Acetate,	5 tons.	Settled tar, 800 gls.
Dissolved tar.	800 gls.	(Part freed from acid liquor and sold as refined tar; used as fuel under boilers).
		Crude methanol, 500 gls.
		Neutral oil 15 gls.

Alcohol Refinery

C.P. methanol 350—400 gls.
Methyl acetone 50 gls.

Tar Plant

Black paint	100 gls.	Acid liquor, 50 gls. (converted into acetate in the still house).
Wood preservative or creosote oil, 200 gls. (supplied to creosoting plant)		Light oil, 50 gls. (used to make black paint).
Pitch, 1 to 1½ tons		Heavy oil, 50 gls. (used to make creosote oil).
Disinfectant (Kreso) 50 gls.		

Uses for the Products

Acetate of lime is mainly used for the manufacture of acetone for making cordite, in the manufacture of acetic acid which finds application in the textile and rubber industries and in the manufacture of cellulose lacquers and artificial silk. Considerable quantities of acetate of lime have been supplied to the Cordite factory, Aruvankadu.

Methanol is used in the manufacture of formaldehyde or "formalin," in the dye and explosives industry, and in de-icing mixtures. Some quantity is used in making paints, varnishes, polishes, etc. The "denaturing grade methanol" is in demand as denaturant for ethyl alcohol used for industrial purposes.

Methyl acetone is being used as an industrial solvent and in paint removing compositions.

Tar and tar products find a ready local demand.

The local market for the other products being limited and cheaper synthetic processes having been evolved for acetic acid, acetone and methanol, the wood distillation plant and the chemical plant are working on a restricted scale, the bulk of charcoal required for the blast furnace and for other metallurgical purposes being made in the forests in country kilns and in C.I. kilns designed and developed at Bhadravati.

Formaldehyde Plant

A small pilot unit for production of formalin by the catalytic oxidation of methanol has been set up at Bhadravati. The rated capacity of the plant is about 6 tons per month. This plant is the only unit of its kind in India at present and has been very serviceable in meeting urgent military and civilian requirements in India during this war.

Uses of Formaldehyde.—In the manufacture of bakelite moulding powders, in hardening leather, for fixing glue, in the manufactures of dyestuffs, in the textile industry, for waterproofing, for the manufacture of gelatine used in printing industry, in artificial silk production, for the manufacture of hexamine, etc.

Future Developments

The latest development in the wood distillation industry aims at the direct conversion of pyroligneous liquor into acetic acid without going through the intermediate step of the lime acetate. Though several processes have been advanced the most promising ones only need be mentioned here.

The Suida Process discovered by Suida, an Austrian professor. In his process, the

acetic acid is extracted from the vapourized pyroligneous liquor by wood tar oils. Steam and alcohol pass over and the latter is separated in the usual way. From the extract acetic acid is released and refined. Two small plants, one in Yugoslavia and one in France, have been working the process and one American plant is also stated to be in operation. It is claimed that acetic acid can be made by this direct process from pyroligneous liquor, at the same cost as that incurred for the intermediate product only, viz., the lime acetate.

The Melle Process.—A more economical process has recently been developed. In this process, the "Melle Process", the retort vapours are first detarred. The detarred pyro-liquors are then extracted with ethyl acetate in the cold in a deacidification battery, the extract is then fractionated when anhydrous acid (Technical grade) is got and the alcohol and acetone passing as vapours are collected separately.

In this process, the steam consumption is much lower, the extraction being in the cold. Recovery is about 95 per cent. of the total acids in the pyroligneous liquor. The process is stated to compete successfully with synthetic acid.

As there is a comparatively larger demand, both present and potential, for acetic acid than for acetate of lime in India, and closely situated countries, such as Ceylon, Java and Malaya States import considerable quantities of acetic acid for the rubber industry, it is under active contemplation to install a plant at Bhadravati for direct recovery of acetic acid from the pyroligneous liquors. A formaldehyde plant of a higher capacity to serve the growing plastics industry is also under consideration.

Collected Papers on Metallurgical Analysis by the Spectrograph. Edited by D. M. SMITH (British Non-Ferrous Metals Research Association) 1945. Pp. xi+162.

THE book contains a series of research reports on the quantitative analysis of non-ferrous metals and their alloys by the use of the spectrograph. The metals and alloys investigated are aluminium and aluminium alloys, lead and lead alloys, zinc alloys, copper alloys and platinum. The elements in aluminium alloys present as impurities or as alloying elements, which have been spectrographically determined are magnesium, iron, silicon, manganese, nickel, titanium, zinc, chromium and copper; in lead alloys, tin, antimony, bismuth, cadmium, copper, iron, nickel, cobalt, silver and zinc; in zinc alloys, aluminium, copper and magnesium; in copper alloys, aluminium, beryllium, and cobalt; and in platinum alloys, silver, bismuth, copper, gold, lead, tin, nickel, palladium, iron, cobalt, tellurium, zinc, rhodium, arsenic, antimony, ruthenium and strontium. The accuracy claimed is as good as that of the chemical determinations. The spectrographic method has been found to be more rapid, and it enables one to determine small amounts of impurities not possible chemically. It has also been found possible, in some cases, to read very small percentages of impurities by mere visual observations of the blackenings produced by the spectral lines on the photographic plates.

The method generally adopted is what is known as the Internal Standard method, and the plate-calibration is carried out by means of the spectra of a few standard samples. No elaborate arrangement either for the excitation of spectra or for the calibration of plates by imprinting on them intensity patterns has been found necessary. The procedure, therefore, is very simple and straightforward and will, in consequence, appeal to all those interested in the analysis of non-ferrous alloys.

It has, however, been mentioned in several places that the reports are of a preliminary nature. When published in book form, the results should have been finalised, so that

the readers could utilize the findings with certainty.

A very interesting feature in the spectrographic analysis of aluminium alloys, is the observation that the results obtained by the "direct comparison" method, as distinguished from those obtained by the "Internal Standard" method, have been found to be fairly accurate; for magnesium also in certain cases the former method yields more accurate values than the latter. It is rather peculiar that the intensity of the lines of the alloying elements in different spectra maintains the required proportionality with the percentage of these elements irrespective of the overall intensity of the main spectra. The author also does not claim that any extra precaution other than that necessary for general spectro-chemical analysis, is needed. In view of the fact that the method cuts down the amount of photometric work considerably, it should be more extensively studied to see if the results obtained are not merely accidental, and if it can be applied to other spectro-chemical analyses as well.

K. C. MUZUMDAR.

An Introduction to the Theory and Design of Electric Wave Filters. By F. SCOWEN (Chapman and Hall Ltd., London), 1945. Pp. xi+164. Price Sh. 15.

Electric wave filters have assumed great importance due to recent developments in carrier telephony and telegraphy, "wired wireless", frequency modulation and other branches of telecommunication. Those engaged in any of these fields will find the book very timely and useful.

The subject matter has been dealt with under four parts. The first, covering 27 pages, is a recapitulation of the mathematical and electrical formulæ needed for an understanding of the theory. The next 40 pages are devoted to the development of the theory of electric wave filters. The various types are well illustrated by diagrams and tables. The third part (60 pages) is intended primarily to help the radio engineer desiring to construct filters. Simplified methods by the help of templates and nomograms for

the determination of image attenuation and phase shift coefficient, dissipation loss and insertion loss are described and will be of value to the designer in avoiding laborious calculations. A useful, though comparatively brief, discussion of the theory of crystal filters is also added. In the last 20 pages the author deals with practical considerations and measurements on actual filters.

The author rightly says in the preface that the book is not intended to replace the standard works of Zobel, Guillemin, Shea, Starr and others, but he can take the credit for having successfully dealt with recent advances in this important subject. The book is well printed and typographical errors, like the omission of X_{∞} in the last line of page 73, are hardly noticeable.

P. K. KITCHLU.

Symposium on Magnetic Particle Testing
(American Society for Testing Materials, Philadelphia 2, Pa) 1945. Pages 122 + v. Price \$1.25.

Among the non-destructive methods of testing materials, the radiographic method is well known. For testing defects on the surface and subsurface regions of ferrous materials, magnetic particle testing can be conveniently used. The method has been known for the last fifteen years or more, but it was widely applied only during the war years, particularly in the U.S.A.

Radiographic methods are expensive and time consuming, and cannot, therefore, be used for large-scale testing. On the other hand, magnetic particle testing affords a comparatively cheaper, quicker and easier method of inspection, and is, therefore, suitable for testing a large number of samples. These methods should not be considered as competitive; they supplement each other.

The *American Society for Testing Materials* has recently published a symposium on this subject, which includes eight technical papers with discussions. The papers deal with the equipment for testing, inspection of parts and application of the method for testing railroad parts, aircraft parts, forgings, castings, weldments, etc. One of the papers deals with the specifications and procedure for testing. Direct and alternating current methods using dry, wet and fluorescent particles are described and their suitability for testing specific parts is discussed.

The book is well illustrated with photographs of different types of testing machines, and of machine parts showing defects such as cracks, tears, chills, inclusion of sand in the casting, etc., as brought out by this method of testing. In addition, inclusion of the two *A.S.T.M.* tentative methods of magnetic particle testing and inspection of commercial steel castings and heavy steel forgings, has increased the usefulness of this volume.

The information brought out in this book is comprehensive and precise. In India, large-scale development of industries such as manufacture of locomotives, aeroplanes, motor cars, ships and capital equipment is contemplated. The magnetic particle testing will prove invaluable to these industries and will help in eliminating defective parts during assembly and in improving processes, materials and designs. The book will be of great help to all those interested in the purchase and manufacture of heavy equipment.

G. D. JOGLEKAR.

Journal of Colloid Science

Published by the Academic Press, Inc., New York, N.Y., and edited by Prof. Victor K. LaMer of the Columbia University, the *Journal of Colloid Science* is a distinct and welcome addition to the literature in colloid science. A copy of the inaugural number (January 1946) has just reached our hands. It is a bi-monthly journal, containing original papers, letters to the editor and book reviews. The Editor-in-chief is assisted by a group of 10 editors, drawn from different countries and consisting of such outstanding scientists like Prof. McBain, Prof. E. K. Rideal, Prof. Tiselius and Prof. Weiser, and a Consulting Committee of 15 scientists including Prof. The Svedberg and Prof. Herman Mark. India is represented on the Committee by Prof. J. N. Mukherjee. The journal is a truly international journal.

The first number consists of 8 original contributions. The first article is by Prof. Szent Gyorgyi on contraction and chemical structure of the muscle fibril. The study of the structure of contractile elements of the muscle has engaged the attention of colloid chemists for over half a century. These elements have been known to contain the protein, myosin. Prof. Szent Gyorgyi has discovered a second protein, actin, and has shown that neither myosin, nor the newly

discovered actin is by itself contractile, but when brought together, they form a complex protein which has the remarkable property of reversible contractility. Actin has the unique property of occurring in two forms, the globular (G) and the fibrous (F). The work of Szent Gyorgyi has led to a satisfactory explanation of muscle contraction. Resting muscle contains its actin-myosin system in the relaxed dissociated condition. Excitation brings about their association to actomyosin, which passes spontaneously into the more stable contracted state. The resting muscle is enzymatically inactive, while the contracting muscle splits adenosinetriphosphate; a relation exists between the quantity of triphosphate split and the tension developed.

Other papers published in the journal are: M. Spiegel-Adolf and E. A. Spiegel, *Polarization and permeability*; William Seifriz, *Torsion in Protoplasm*; H. Jenny, *Absorbed nitrate ions in relation to plant growth*; D. J. Crisp, *Surface films of polymers—Part I*; Victor K. LaMer and Marion D. Barnes: *Monodispersed hydrophobic colloidal dispersions and light scattering properties—Parts I and II*; Paul Stamberger, *The Method of purifying and concentrating colloidal dispersions by electrodecantation*; and William D. Harkins, Richard W. Mattoon and Myron L. Corrin: *Structure of soap micelles as indicated by X-rays and interpreted by the theory of molecular orientation—Part II*.

The Journal is well got up. The annual subscription is \$10.00.

Journal of Polymer Science

The first number of the *Journal of Polymer Research*, published by Interscience Publishers Inc., under the editorial direction of a board consisting of Professors P. M. Doty, H. Mark, and C. C. Price, has just reached our hands. The journal will hereafter be issued under the name of *Journal of Polymer*

Science, and published jointly by Interscience Publishers Inc., and Elsevier Publishers Co. Inc. The Editorial Board is assisted in its work by an Advisory Board of 16 scientists and the scope of the journal is wide enough to include papers based on original research in any aspect of the physics and chemistry of large molecules.

The publication of this specialist journal will be warmly welcomed. The science of polymers is developing at an amazingly rapid pace, the development being influenced, to no small extent, by the large number of applications which high polymers find in industry. It is a field in which specialists in diverse branches of physical science have found common interest and their individual and collaborative labours have led to numerous achievements of high scientific merit and industrial value.

The following papers are included in the first number:—Maurice L. Huggins, *A New Approach to the Theory of Rubberlike Elasticity*; Harry F. Pfann, Van Zandt Williams, and H. Mark, *Mechanism of Peroxide-Initiated Styrene Polymerization*; Wilfred H. Ward, Loretta M. High, and Harold P. Lundgren, *Physicochemical Characterization of Dispersed Chicken Feather Keratin*; T. Alfrey, Jr., E. Merz, and H. Mark, *Experimental Study of Copolymerization*; Charles C. Price and David H. Read, *Mechanism of Vinyl Polymerizations, VIII—Introduction of Foreign End Groups*; Kurt H. Meyer and A. J. A. Van Der Wyk, *Molecular Processes during Deformation of Rubberlike Elastic Bodies*; George Goldfinger, *The Mechanism of Reinforcement, II*.

The annual subscription to the journal is \$8.50 and copies can be had from the publishers. Manuscripts for publication, should be addressed to the Editorial Office, Polytechnic Institute of Brooklyn, Brooklyn 2, New York.

29. MANUFACTURE OF PETROL-PROOF, RUBBERLESS CARBURETTOR TUBES AND ARMoured HOSE-PIPES

PETROL-PROOF tubes and hose-pipes are generally a combination of sheets of synthetic rubber and petrol-proof synthetic resin. India has to depend on imports for supplies of these materials. The acute position of imports during the war resulting in serious shortage, encouraged investigations on the development of petrol-proof tubes and hose-pipes from local raw materials. The process now developed utilizes Indian natural resins, thus obviating the need for synthetic resin and synthetic rubber sheets, with the added advantage of reduction in cost.

Process

The process involves the following steps:—

- (i) Preparation of the resin solution.
- (ii) Wrapping of the fabric strip on a coil of wire having an internal diameter equal to the size of the tube or pipe, with simultaneous application of resin.
- (iii) Repeating the wrapping in (ii) above to achieve the desired thickness depending on the size of the tube or pipe and finishing with a final layer of plain fabric.
- (iv) The tube or pipe is finally braided on a braiding machine and dried.

Experimental Results

Tests were performed on the plastic material, tubes and hose-pipes in the laboratories. Details of the tests are given below:—

Petrol-proofness.—A piece of fabric was coated with D.P.L. and after drying, it was dipped in 100 O.N. fuel for 24 hours. After this period, it was found to have increased in weight only by about 0.7 per cent.

Water sensitivity.—A coated piece dipped in water for 24 hours was found to be unaffected.

Flexing.—A canvas pipe coated with the plasticised resin was flexed at 100 strokes per minute for one hour. The pipe after test was unaffected and leak tight.

Gumming of the Fuel.—The gum content of a sample of 90 O.N. fuel was first deter-

mined. The finished hose-pipe was filled with the same fuel and sealed. After 96 hours, the petrol was taken out and the gum content determined again. The increase in gum content was found to be 0.028 per cent. which is less than the permissible limit.

Contamination.—A sample of 90 O.N. fuel was placed in the hose, which was properly sealed for 96 hours. After this period, the blue colour of the petrol had not changed, indicating thereby that no contamination had taken place. A sample of the plasticized resin has been in the blue fuel for over 2 months without any adverse affect.

Pressure Test.—The carburettor tube was tested in the laboratory upto a pressure of 20 lbs. per sq. inch, which pressure it stood very satisfactorily without showing any signs of leakage, etc. One of the tubes after this test was put on the car of the Director (Physical Laboratories) for service tests. It has given satisfactory service for the last 8 months and no deterioration has been observed as yet. Finished hose-pipes, before being sent for service test were subjected to pressure test in the laboratories. They satisfactorily stood 50 lbs. per sq. in. pressure without showing any leaks.

The results of the laboratory tests mentioned above have been confirmed by the results of tests on the finished hose-pipes which were put on service trials. One piece of hose-pipe about 16' in length and 1.5" internal diameter was sent to *Messrs. Burmah-Shell* and their report is as follows:—

" . . . Branch Engineer has tested the sample hose sent by you to a pressure of 30 lbs. per square inch, and I am glad to say that it has satisfactorily stood this pressure.

" The pressure at which our refuelling pumps usually work is not more than 25 lbs. per sq. in.

" It was also used on one of our refuelling lorries and upto the time of its removal on 1-10-43, 39,795 gallons of spirit had

been pumped through it at a pressure of 20-25 lbs. per sq. in. So far it has stood up to this work very satisfactorily with no adverse effects."

Another hose-pipe of about the same dimensions as above was tested by the Liaison Officer of the R.A.F. in India. His report is equally satisfactory and reads as follows:—

"... The substitute hose for petrol-bowisers has undergone practical tests at the Wellington Airport under the supervision of R. & D. Section with highly satisfactory results.

"The hose was used in a *Burmah-Shell* refuelling lorry for a period of seven weeks, during which time over 50,000 gallons of No. 90 octane fuel passed through it without any signs of leakage or the deterioration of the hose whatsoever."

Satisfactory report has also been received from *Burmah-Shell, Bombay*, about the service life of the hose-pipe after one year's service.

Raw Materials

All the raw materials required are easily available in the country.

Equipment

- (1) Autoclave of 2 gallon capacity to stand a pressure of 300 to 350 lbs./sq. in.
- (2) Winding lathe for wrapping of fabric and simultaneous application of resin (design to be given by the *Council*).
- (3) Three 24 to 32 spindle braiding machines.
- (4) Non-ferrous crucible casting equipment.
- (5) Small workshop to manufacture brass couplings for carburettor tubes and hose-pipes consisting of three lathes, drill and miscellaneous workshop tools, etc.
- (6) Miscellaneous accessories.

The above mentioned equipment, excluding the cost of erection, etc., is not expected to cost more than Rs. 25,000.

Building Space

A total covered area of approximately 3,000 sq. ft. is considered quite sufficient.

Estimate of Cost

Tables below give the approximate cost of the manufacture of carburettor tubes and

hose-pipe of 1.5" diameter. There are quite a number of commercial sizes of hose-pipes, ranging from 0.75" to 3", and the example given is just to give a comparative idea. In pipes of bigger dimensions, the margin of profit is much higher.

The prices of raw materials are now showing a progressive decline and in the near future they could be expected to cost only 50 to 60 per cent. of the costs given below:—

I—Carburettor Tubes.

Estimate for a daily production of 100 tubes of one foot length.

	Rs. a. p.
Tube—	
Raw materials.. .. .	18 9 9
Labour	8 0 0
Fuel and power (¼ maund of coal and 5 kilowatts at Delhi rates) ..	0 12 0
	Rs. 27 5 9

Cost per tube ..	Re. 0-4-5 (approx.)
Coupling—	
Raw materials (10 seers of brass) ..	12 8 0
Labour (covering cost of casting and machining)	32 0 0
Fuel and power (¼ maund of coke and 10 kilowatts at Delhi rates) ..	3 8 0
	Rs. 48 0 0

Cost per coupling.. Re. 0-7-9 (approx.)

Thus the cost of complete tube excluding depreciation and overhead charges comes to less than a rupee. The fact that the development is an economic proposition will be quite evident from a comparison with the present selling price of Rs. 5 of medium quality tubes while better quality imported tube costs about Rs. 7 each.

II—Hose-pipe 1½" diameter and 16' length.

	Rs. a. p.
Raw materials.. .. .	18 14 4
Labour	2 0 0
Power (8 kilowatts at Delhi rates) ..	0 8 0
	Rs. 21 6 4

Cost of pipe per ft. (without coupling, .. Re. 1-5-6 approx.)

Coupling—	
Raw material (1½ seers brass) ..	1 9 0
Labour (covering cost of casting and machining)	2 12 0
Power (3 kilowatts at Delhi rates) ..	0 3 0
	Rs. 4 8 0

The pre-war price of such pipes without coupling used to be approximately Rs. 2 per foot.

Reports from States and Provinces

Punjab

Industrial Research and Development

THE Department of Industries has set up a well equipped Industrial Research Laboratory in which investigations on the possibilities of starting new industries from indigenous raw materials, and on the improvement of existing industries, are undertaken. The Laboratory has examined a number of raw materials such as clays suitable for pottery, vegetable oilseeds and oils, wheat, rice and maize for starch, essential oil containing materials, tannery wastes, etc. Reports on the results obtained have been published, and a number of new industries have come into existence. The more important among them are: manufacture of plaster of Paris (medical), dipped rubber goods, metal polishes, pottery ware, chemicals, e.g., tannic acid, ammonium chloride, manganese sulphate, potassium hydroxide, chromic acid, tartaric acid, potassium carbonate and salts of barium. Most of these industries have secured a permanent footing in the industrial structure of the province as a result of the impetus afforded by the war.

The raw materials under investigation are: lime, ammonium chloride, several minerals, soap-nut, pulses, asbestos, lead and saltpetre. Some of the more important investigations on the improvement of existing industries relate to the production of gelatine capsules, preparation of unbreakable glass substitutes, dehydration of alcohol, reclamation of lubricating oils, gasification of petrol at various temperatures, production of fatty acids from oils, building materials, e.g., waterproof indianite, colouring material for vegetable ghee, and pigments. The possibility of establishing mining and pharmaceutical industries in the Kulu Valley has been indicated by the work carried out in the laboratory. The problems of research are numerous and plans for reorganizing the laboratory and expanding its scope, are under consideration.

A scheme for research on the industrial utilization of Punjab coal has been sanctioned by the Government.

The Government have established an Industrial Research Fund for pooling the resources of Government, semi-Government and private laboratories for the general industrial development of the Province. The fund was started with a sum of Rs. 1,50,000. Contributions are made to it every year, and the total amount after allowing for the expenditure, now stands at Rs. 2,03,287.

The Punjab Government have constituted a Provincial Industrial Research Committee with a view to assisting the co-ordinated development of indigenous industries and for preventing duplication of research. The problems dealt with by the Committee include the manufacture of boot polishes and leather preservatives, manufacture of electrical insulators, preparation of synthetic vitamins, production of plastics and colloidal solutions for therapeutic applications in medicine and catalysts in industry.

Investigations of interest to industry are carried out in all the specialized institutes of the Department.

A survey of the industrial resources of the Province was initiated by the Department in 1938. The survey is being conducted industrywise and district-wise. Surveys of several districts have been completed. The report on the survey of Ludhiana District has been published and those relating to other districts will be published shortly. The tanning, ceramics,

textile and vegetable oil industries have been surveyed on a provincial basis and the reports are under compilation. A Survey Advisory Committee has been constituted to approve the final reports.

Demonstration Factories have been established with a view to giving lead to new industries, and also to stimulate existing ones. The Department maintains three Demonstration Factories for weaving, pottery and glue.

Considerable work on the development of sericulture in the Punjab has been carried out by the Department. In 1935, when sericulture was transferred to the Department, about 100 ounces of silk seed were imported from France and Italy for distribution amongst the rearers. The Punjab is now, not only self-supporting, but it also supplies the requirements of some of the adjoining States. This remarkable development has been achieved by establishing two grainage stations, one at Dalhousie and the other at Palampur. A number of nurseries and mulberry plantations have been established in various localities. The rearers are taught to rear silk-worms under scientific and hygienic conditions. A Demonstration Filature and Silk Throwing Factory has been established at Amritsar.—(Contributed.)

Hyderabad

Scientific and Industrial Research Board

The Board was reconstituted during 1944-45 as an Advisory Board to the Governing Body of the Central Laboratories for Scientific and Industrial Research, the establishment of which has been already announced. The allocation of funds to the research committees under the Board is shown below:—

Committee	Amount sanctioned Rs.
Vegetable oil utilization	6,643
Pharmaceuticals and drugs	8,333
Fibre research	3,060
Heavy chemicals	14,348
Ceramic research	12,737
Fuel	3,833
Forest products utilization	900
Industrial fermentation	3,785
Exploratory committee on essential oils	2,100
Insect pests of stored wheat	3,560

Research Schemes

Sixteen research schemes were in operation during the year. The work under the following six schemes were completed:—

- (1) Distillation of groundnuts for obtaining fuel oil.
- (2) Electrolytic production of potassium permanganate.
- (3) Flexible fibre boards from local raw materials
- (4) Photographic gelatine.
- (5) Acid resistant enamels from local raw materials.
- (6) Giemsa stain.

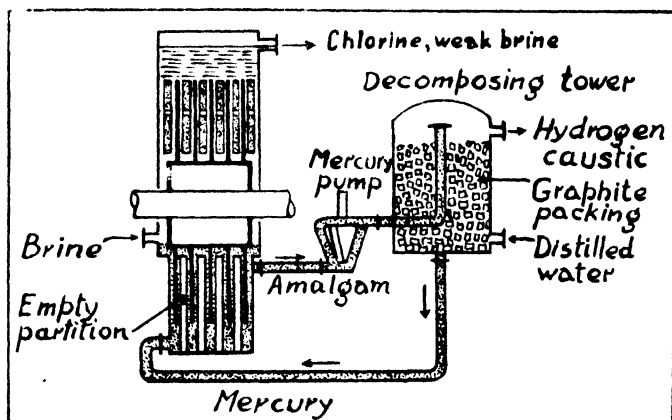
Work on the following schemes is in progress:—

- (1) Dehydration of castor oil.
- (2) Preparation of sulphonamides.
- (3) Examination of local fibrous materials for paper and cardboard manufacture.
- (4) Transparent paper.
- (5) Processing of ammonium nitrate for use as a fertilizer.
- (6) Cast iron and one-coat enamels.
- (7) Distillation of groundnut husks.
- (8) Low-temperature carbonisation of Hyderabad coal.
- (9) Preparation of peptone.
- (10) Insect pests of stored wheat.

Vertical Chlorine Cell

THE U.S. team of experts who went to Germany to investigate war-time developments of German industry have reported a novel vertical rotating cathode mercury cell which has been developed by the I.G. Farben (*Chem. and Met. Eng.*, 1946, 53, 113).

The vertical cell occupies only a fraction of the floor space required for the conventional horizontal types, and at the rated capacity of 24,000 amps., its chlorine output per sq. ft. is three times that of the modern horizontal cells. A sketch of the vertical section of the cell as put up at Ludwigshafen is given below.



In operation, the five rotating steel cathodes become amalgamated as they pass through the mercury in the bottom of the cell. It was stated that the mercury coating spreads thinly over the entire surface and persists for 24 hours even when no current is passing through the cell. When the current is on and the cathodes are rotating, the mercury coating picks up the sodium formed by electrolysis of the brine. As the cathode moves out of the brine zone into the mercury, the amalgam dissolves in the mercury bath and is replaced by mercury of lower sodium content from the bottom of the cell. The Hg-Na amalgam containing 0.15 per cent. sodium is circulated into the "decomposing tower." Where the sodium content is reduced to practically nil by interaction with water to form caustic soda solution of 50-70 per cent. and the pure mercury flows by gravity out of the bottom of the tower and back to the opposite end of the cell and the process is continuous.

At the rated capacity of 24,000 amps., it requires only about 19 sq. m. of floor space including aisles, per 1,000 kgm. of chlorine per day, as compared with 60 sq. m. for 16,000 amps. horizontal mercury cells and even more space for horizontal cells of lower amperage. Losses are between 0.5 and 1.25 lb. of mercury per ton of chlorine, and carbon (used as anode) consumption is given as between 0.45 and 0.65 kgs. per 100 kg. of chlorine. Power consump-

tion is stated to be 360 to 400 kwh. of D.C. per 100 kgs. of sodium hydroxide. Percentage composition of the anode gas is given as: 97 chlorine, 1.0 carbon dioxide, 1.6 hydrogen, 0.4 carbon monoxide, oxygen and nitrogen. The per cent. analysis of caustic solution after filtration through porous carbon candles is: Sodium hydroxide, 50; sodium chloride, 0.004; sodium carbonate, 0.33; sodium sulphate, 0.03; ferric oxide, 0.0016; alumina, 0.20; sodium perchlorate, 0.00.

A. L. S.

Currents in Thin Dielectrics

The results of an interesting study on the nature of the components of current flowing through high grade dielectrics subjected to a uniformly increasing D.C. stress have been recently published (Austen and Whitehead, *British Electrical and Allied Industries Research Association, Report L/T-96*, 1945). The rate of increase is so regulated that breakdown would occur in about 30 secs. Setting aside the normal charging current, it is found that the remaining current is mainly anomalous and that the conduction current is only a negligible fraction. The anomalous current consists of two parts, one being reversible and the other irreversible.

The authors maintain that since the variation of anomalous current with stress in dielectrics is continuous, any discontinuity is probably to be regarded as evidence of gross defects in the dielectric. The variation of anomalous current with time was found to be roughly expressible in the general form $\beta e^{-\alpha t}$. Most dielectrics show a more or less abrupt transition from a region in which the loss angle is substantially independent or varies slowly to one in which the loss angle and permittivity increase rapidly with increase of stress.

In mica the anomalous current is smaller than had been anticipated, and no considerable discontinuity occurs upto breakdown. For cellulose acetate the anomalous current is considerably greater than in the case of mica; the relaxation time is larger and the variation with stress is small. The quantity β increases continuously with stress, while α shows little change. In the case of condenser tissue impregnated with transformer oil, both relaxation time and coefficient β increase greatly with stress, while α decreases with stress. The presence of air appears to cause an increase in relaxation times.

D. K. D. G.

A Balanced and Repeating Time Base

A repeating time base of widely adjustable sweep time, developed primarily for the study of high frequency phenomena near zero current in A.C. circuit breakers, has been described by Mason (*British Electrical and Allied Industries Research Association Report No. G/T.176*, 1945). The circuit employs a

thyatron working with a value of anode current which lies in the threshold region between true thyatron operation and that of a hard triode. The sweep time can be varied from 3,000 μ secs. to 1 μ sec. while the voltage is variable over a range of 250 volts to 2,000 volts, the higher voltages giving a very long trace on which small time elements can be easily measured. A calibration oscillator is also incorporated in the instrument. The time base is balanced with respect to earth to provide a clean and accurate trace. The circuit has provision for supplying either "beam-trapping" or "beam-modulating" voltage to eliminate the return sweep. The repetition frequency of the time base can be increased up to about 200 times per second, but it works most satisfactorily when single sweeps are used or when the repetition frequency is small. The author expects that the provision of this wide range of sweep times and sweep voltages will make the instrument suitable for use in fields other than that for which it was specifically designed. The circuit is assembled in a light, compact and portable unit in which every part is easily accessible, thus facilitating its servicing and repair.

B. N. B.

Measurement of Forces Between Fibres During Drafting

An instrument for the measurement of drafting force is described in a recent memoir issued by the Shirley Institute (Martindale, *Shirley Inst. Mem.*, 1944-45, 19, 387). The apparatus consists of three lines of drafting rollers, the front pair being mounted in a cradle in such a way that the cradle is deflected when a force is applied to the rollers. This deflection operates a simple recording device and a photographic record of the variation of the drafting force can be obtained. The lamp in combination with a lens and prism system provides the beam of light for recording purposes.

The cradle is suspended from the supporting framework by means of a flat spring. The cradle is able to deflect about a line and this deflection is used to measure the force applied between the front and middle roller nips when cotton is being drafted. The sensitivity of the instrument can be altered by fitting springs of different thickness.

The deflection, which does not exceed 0.1 mm. measured at the front-roller-nip, is magnified by a mechanism.

The middle and back rollers are carried in brackets mounted on a metal slide screwed to the same base plate as the front roller assembly. There is a fixed break draft of 1.2 between these two lines, and the back roller is driven from the gear box through two Hooke joints connected by a telescopic tube. The gear box provides total drafts of 3, 5, 7, 9, 11 and 13. The front roller system is made very light. The flutes on the bottom rollers instead of being cut parallel to the roller axis are at a small angle to it. The front rollers are normally driven so as to deliver 30" of sliver per minute.

Two methods of recording have been adopted. One gives a continuous record of deflection, i.e., drafting force, and the second gives the frequency distribution of drafting forces.

The principal features in the design of the camera are simplicity of construction and ease of loading and removal of the photographic paper. The sensitivity of the apparatus can be most easily altered by varying the thickness of the spring. Each time a change of sensitivity is made, the apparatus has to be calibrated.

The actual procedure adopted in measuring the drafting force is as follows:

A few yards of sliver are taken and laid on the table behind the draw frame. A photographic trace of drafting force is then obtained and, after all the sliver has passed through, a short length of photograph is made with no cotton being drafted. This is sufficient to give zero position from which to measure force and also to show that no serious unwanted vibrations are present. A suitable weight is then placed on the scale pan, attached by spring to the cradle and another short length of photograph made. The displacement from zero shown by this length serves to calibrate the scale of the photograph.

V. V. G.

Metal Powder Sintered Bearings (Oil-Impregnated)

A. S. T. M. Specifications.—The American Society for Testing Materials has accepted the following specifications approved by the sponsoring committee, for use pending their adoption as standard.

These specifications cover sintered metal powder, oil impregnated bearings of two types and four classes as follows:

- (a) Type I, Bronze Base:
 - Class A (*d*, 6.4-6.8): Copper (87.5—90.5), Tin (9.5—10.5).
 - Class B (*d*, 6.5-6.9): Copper (82.6—88.5), Lead (2.0—4.0), Tin (9.5—10.5).
- (b) Type II, Iron Base:
 - Class A (*d*, 5.7-6.1): Iron (95.0 min), Carbon (0.5—2.0).
 - Class B (*d*, 5.8-6.2): Iron (67.0—92.0), Copper, (5.0—30.0).

Bearings shall be made by briquetting and sintering metal powders so as to produce finished parts conforming to the requirements of these specifications.

The material shall conform to the requirements as to chemical composition and the density of bearings supplied fully impregnated with lubricant shall be within the limits prescribed.

Porosity in terms of inter-connected void space by volume shall be not less than 18 per cent. for all classes when calculated as follows:

$$P = \frac{B-A}{(B-C)S} 100.$$

where:

- P* = Porosity by volume of interconnected void space in per cent.
- A* = weight of lubricant-free sample in gms.
- B* = weight of oil-impregnated sample in gms.
- C* = weight of oil-impregnated sample immersed in water in gms., and
- S* = specific gravity of impregnant at the temperature of test.

The radial crushing strength shall not be less than the value calculated as follows:

$$P = \frac{KLT^2}{D-T}$$

where:

- P* = radial crushing strength in lbs.
- D* = outside diameter of bearing in inches.
- T* = wall thickness of bearing in inches.
- L* = bearing length in inches, and
- K* = strength constant (Type I, class A and B, 22,500, and Type II, class A and B, 40,000).

Bearings shall be uniform in composition. When cut or fractured, the exposed surface shall be of uniform appearance. The parts shall be free from defects which would affect their serviceability.

In calculating permissible loads, the operating conditions, housing conditions and construction should be considered. In general, Type I material has more resistance to seizure and corrosion than Type II material. The maximum static bearing load should not exceed 8,500 psi of projected bearing area (length times inside diameter of bearing) for Type I material, nor 15,000 psi of projected bearing area for Type II material. These figures are 75 per cent. of the values for the compression deformation limit (yield strength, permanent set of 0.001 in. for specimens 1.5" in diameter and 1" in length as determined in accordance with the Tentative Methods of Compression Testing of Metallic Materials (A.S.T.M. Designation : E 9).

Tin During the War

The Hague Office of the *International Tin Research and Development Council* has issued its first post-war Statistical Bulletin (February 1946) from which the following information is derived.

Production.—World's tin production which amounted to 149,700 tons in 1938, was stepped up in 1939 and 1940, reaching its peak of 245,500 tons in 1941 (estimated). The highest production before this date was recorded in 1937 (209,100 tons). The production was much lower after 1941 due to the war in East Asia.

Consumption.—No estimate can be made yet in respect of world's tin consumption during the war years. The tin used in manufacture in U.S.A. in 1939 was 70,315 long tons. The consumption rose to 10,870 long tons in 1941 and declined to 60,000 tons in 1942, 56,000 tons in 1943, and 65,000 tons in 1944. The position was somewhat similar in the U.K. The consumption figures for the quinquennium 1939-44, being 27,279, 29,225, 30,000, 23,478, 17,631 and 18,435 respectively.

Prices.—The tin prices in U.S.A. and England were fixed by the Governments during the war. The average price for the period 1939-45, being 51.43 cents per lb. in the U.S.A., and £270.6 in the U.K.

Owing to destructions done to several of the large smelters, world's smelting capacity will presumably show a temporary decline, which is counter-balanced, however, by the fact that during the war an American-owned smelter of great capacity was established in the U.S.A. It may be assumed that at the present moment the total smelting capacity available will be considerably in excess of world's production.

Vitamin A from Ionone

Vitamin A has been synthesised from β -ionone, the synthesis involving eight steps. The yield is said to be 15 per cent. Besides β -ionone, the chemicals required in the synthesis, according to a report from Prof. N. A. Milas of the Massachusetts Institute of Technology, are, ethyl chloracetate, acetylene and derivatives of β -hydroxybutanone-2. The synthetic product is biologically active.

Thorium Deposits of Travancore

With the realization of the importance of thorium as a source of atomic energy, the thorium-bearing monazite sands of Travancore are attracting world-wide attention. The sands extend over 90 miles in length along the coastline, and are the property of

the State. For 20 years and more, monazite ilmenite was being exported, mostly to America. The strategic importance of thorium deposits had hardly been realized until the discovery of the atomic bomb.

Thorium can be used as a source of atomic energy, if "primed" with substantial amounts of uranium. According to a report from Washington, "Thorium cannot maintain a chain reaction either by itself or in combination with any natural material other than uranium. But with a fairly substantial amount of uranium to begin with, and suitably large quantities of thorium, a chain reaction can be established to manufacture a material which is an atomic explosive and which can also be used for maintenance of other chain reactions."

India's deposits are largely concentrated in Travancore. While there are no published reports on the uranium deposits, it has been long known that India ranks first in her thorium supplies, Brazil holding the second place. The Government of Travancore are fully alive to the importance of the deposits. The Government have recently invited Sir C. V. Raman to accept the Hon. Professorship of Physics of the Travancore University and to assist the Government in preparing a scheme of research into the mineral resources of the State.

Sicilian Sulphur

The present position of the sulphur industry in Sicily is discussed in a report by Mr. C. A. Botford, Minerals Attache, U.S. Embassy, Rome. (*C.T.J.*, 1946, 118, 362). The average annual output in the pre-war years was 300,000 tons. The production decreased during the war and the output was about 55 per cent. of the pre-war figure.

All sulphur mining ceased by the latter part of the year 1943, due to lack of power from plants at Porto Empedocle, Catania, and Palermo which were badly damaged by bombing. In September 1943, the Allied Military Government authorized the resumption of sulphur mining. Production started in December 1943 and some 300 tons were raised in that month. It was stepped up gradually and by the first half of 1945 the production fluctuated between 3,500—6,000 tons per month.

Fifty mines are reported to be in operation employing less than 5,000 workers. The output per man has fallen. It is stated that if the market and economic conditions are favourable the production can reach 150,000 tons a year in the course of three years.

D.D.T.

Tests carried out in Australia have shown that DDT is effective against:—Aphids (except Grey Aphid of cabbage); Bean Fly; Green Vegetable Bug; Tomato Leaf Hopper; Cotton Jassid; Cabbage Moth and Cabbage White Butterfly; Climbing Cutworms (e.g., Corn Ear Worm); Potato Moth; Beet Worm; Codling Moth; Pear Slug; Sorghum Midge; Buffalo Fly; Cattle Tick. Tests are proceeding, and official recommendations for control of these pests are due soon.

DDT has not proved effective against the various mites, e.g., Red Spider, Bryobia Mite.

Anti-Locust Expedition to Middle East

Periodical locust invasions from the Middle East have been a source of danger to crops in Northern India and Government have to take effective measures to ward off the menace.

Arabia and Persia are among the countries from which swarms migrate towards the East every spring and summer. The Government of India have been sending locust control parties to these countries to assist the local authorities. Last year Government undertook to carry out operations at the request of the Persian Government in certain parts of Persia.

This year the Government of India assumed direct responsibility for anti-locust campaign in South-East Arabia and a delegation consisting of about half a dozen trained officers was sent to Sharjah some time ago. The party is engaged in carrying out the necessary operations and the campaign is likely to continue for three to four months.

The method of destruction is that where the soil is sandy, trenches are dug in front of moving bands of hoppers (wingless locusts) which always move in a certain direction. They fall in the trenches and are immediately buried. In areas where labour is scarce and soil is hard, as in Baluchistan, Persia and some parts of Arabia, bran mixed with poison is spread in front of the moving bands which readily eat the moist bran and die within two or three days.

The locust comes in cycles. The last cycle started in 1940. The locusts breed in India and East Africa during summer and in the Middle East during winter and spring. They migrate from East Africa and India towards the Middle East in autumn. Due to successful operations in India no swarm has gone from the Indian side towards the Middle East during the last three years. Unfortunately success has not been equally great in East Africa and there has been breeding every season in Arabia. As long as all the three regions do not succeed in preventing swarms going out of the respective areas, the trouble will continue.

Research in Tobacco

A scheme for the development of Virginia cigar tobacco in the area around Muzaffarpur (Bihar) was considered and accepted at the second meeting of the Indian Central Tobacco Committee held recently in New Delhi.

The scheme provides for the supply of pure line tobacco seed, practical instructions to cultivators on all cultural operations and curing.

It was decided to open a number of research stations for work on cigar tobacco including one at Rajahmundry. For *bidi* tobacco arrangements are nearly complete for setting up a station at Anand. A station for *hukka* and chewing tobacco will be located in Bihar. A Central Research Station for fundamental work on all types of tobacco is to be established at Guntur.

Realizing the need for dissemination of information about improved methods of cultivation and organization of an efficient marketing intelligence service, the Committee decided to publish pamphlets in popular language for the benefit of tobacco growers and to arrange for demonstration by cinematograph films.

Opium Policy

Replying to questions put in the Council of State on 11th April 1946, by the Hon'ble Raja Yuveraj Dutta Singh, on the opium policy of the Government of India, the Hon'ble Mr. V. Narahari Rao said: "Poppy cultivation for the manufacture of opium is confined in British India to a limited area in the United Provinces. The area is fixed every year with

reference to the requirements of opium for home consumption, manufacture of alkaloids and exports. The general policy is to limit cultivation of the poppy as much as possible and to reduce the consumption of opium in India. The position is kept under constant review. While the consumption of opium by addicts and its use as a prophylactic or anodyne or as a household remedy by people to whom qualified medical assistance is inaccessible are tolerated, every step is being taken to check abuse and to reduce consumption. The people of India have by long experience acquired an empirical skill in the use of opium for medical and semi-medical purposes, and until proper medical aid becomes generally available throughout the country, it would be neither practicable nor humane to prohibit the use of opium altogether. The Government of India are, however, at present reviewing the whole field in consultation with the Provincial Governments and the States, and in particular are examining the practicability of suppressing opium smoking.

"As regards exports since the beginning of 1936, the export of opium from India is not allowed except in the following cases: (i) small quantities sent to the French and Portuguese settlements in India, Nepal, Zanzibar and Pemba in accordance with long-standing practice; (ii) quantities sent to Burma and Aden which until recently formed part of India; and (iii) exports of raw opium to the United Kingdom for the manufacture of alkaloids."

Central Food Advisory Council

At the *Central Food Advisory Council* meeting held on 5th April, the Hon'ble Sir Jogendra Singh revealed that Government had decided to set up a Central Groundwater Section to tap sub-soil resources. Government were able to secure the advice of Mr. Roscoe Moss, an American expert. He and Sir William Stampe, Irrigation Adviser to the Government of India, had recently toured various parts of the country and drawn up a plan to carry out boring operations. All machinery for the purpose had been purchased from the U.S.A.

The total acreage under principal foodgrains had increased by over 13 million acres during the triennium ended 1944-45. Over 2 million acres of culturable waste and 0.3 million acres of fallow land had been brought under cultivation. There were practical difficulties in bringing large tracts of culturable waste under the plough, e.g., lack of irrigation facilities, tractors and manure, but he expected that much progress would be made during the next 12 months and hoped that in a few years India would be self-sufficient in the matter of food production.

The export of uncrushed bones had been totally stopped. Crushed bones were, however, allowed to be exported, as it enabled the bonecrusher in India to reduce the price of bonemeal, which is a by-product of the crushing industry and is an excellent manure.

The total quantity of sulphate of ammonia allocated to India by the Combined Food Board during the period 1st July 1945 and 30th June 1946, is 154,000 tons. For the fertilizer year 1st July 1946 to 30th June 1947, the Department of Agriculture has indented for 240,000 tons of sulphate of ammonia, 20,000 tons of which will be produced in the country. Reports indicate that the Travancore Factory will be operating by June 1946, but it is doubtful if appreciable quantities would be available from that source until much later.

Control on Coal Tar Products Removed

The Central Government have, by a notification published in the *Gazette of India* dated 13th April 1946, cancelled the Coal Tar Products Control Order, 1945, as the supply position in regard to coal tar products is considered satisfactory.

Department of Works, Mines and Power

The division of the Labour Department, with the establishment of a new Department of Works, Mines and Power, came into effect on 8th April 1946 (*Gazette of India Extraordinary*, Friday, 5th April).

The Department of Works, Mines and Power deals with such subjects as the Central Public Works Department and execution of Central Works Projects, Civil Engineering, Mines and Minerals, the Geological Survey of India, Major Irrigation Works including Central Waterways, Irrigation and Navigation Commission, Electricity and Stationery and Printing.

The Labour Department continues to deal with all subjects connected with the *I.L.O.*, Welfare of Labour, Labour Relations, Social Security Measures, Legislation and Enforcement of Labour Laws, Safety Measures, Resettlement of Ex-Servicemen and Women, Technical and Vocational Training Schemes, Labour Bureau, Statistics, Research and Investigation.

The administrative control of the Office of the Electrical Commissioner with the Government of India has been transferred from the Department of Industries and Supplies to the new Department of Works, Mines and Power. The Office of the Electrical Commissioner will continue to be located in Calcutta for the present.

Central Advisory Board of Education

The following gentlemen have been nominated by the Government of India in consultation with the Crown Representative to represent the Indian States on the Central Advisory Board of Education in India:—

(1) S. M. Azam, Esq., M.A. (Oxon), Education Member, His Exalted Highness the Nizam's Executive Council; (2) Rai Bahadur R. C. Kak, Prime Minister, Kashmir; (3) Dr. T. C. M. Royan, M.D., Minister of Education and Public Health, Mysore.

Cess on Oilseeds

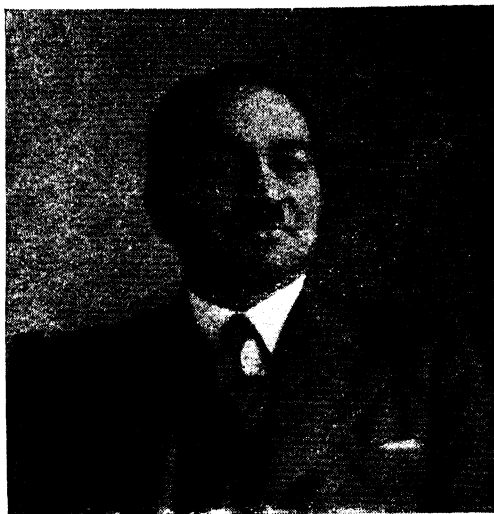
The Indian Oilseeds Committee Bill introduced by Sir Pheroze Kharegat, was passed by the Central Legislature on 3rd April 1946.

The Bill seeks to provide for the creation of a fund to be expended by a Committee specially constituted for the improvement and development of the cultivation and marketing of oilseeds, and of the production, manufacture and marketing of oilseed products.

The total value of oilseeds produced in India was about Rs. 200 crores a year. The Bill authorizes the levy of a cess on oil crushed in the mills, thus exempting the cakes from the incidence of the cess. It is proposed to impose in addition an export duty at the rate of 2 annas a maund on exported oilseeds. A cess of half per cent. *ad valorem* was already levied on oilseeds now exported and the cess proposed in the Bill would be in addition to that. The export of oilseeds is dwindling and the imposition of the cess on exports is hardly likely to yield any substantial income to the fund.

It is hoped that Indian States would levy a corresponding duty on oil extracted in the mills and make

over the amount thus realized to the Oilseeds Committee. This would be a matter for negotiation.



SIR SHANTI SWARUP BHATNAGAR, O.B.E., D.SC., F.R.S.

Announcements

Sir Shanti Swarup Bhatnagar, O.B.E., D.Sc., F.R.S., has been elected a Fellow of the University College, London.

The Joykissen Mookerjee Gold Medal for 1944, and the H. K. Sen Memorial Medal for 1946, have both been awarded to Sir Shanti Swarup Bhatnagar. The former is awarded annually by the *Indian Association for the Cultivation of Science*, for an "eminent scientist whose association with the institution is considered by the management to be in the best interests of scientific progress in India." The H. K. Sen Memorial Medal is awarded annually by the *Institution of Chemists (India)* to an "eminent industrial chemist selected by the Council of the Institution."

Nuffield Research Fellowships. The Trustees of the Nuffield Foundation have decided to offer to Indians, Australians, Canadians, New Zealanders and South Africans a number of Medical Travelling Fellowships in the years 1946-47. The object of the Fellowships is to enable suitably qualified persons from the countries concerned to obtain in the United Kingdom such post-graduate training and experience as may be necessary to prepare them to undertake subsequently medical teaching and research work on their return to their own countries. Each Fellowship, the annual value of which will be between £300 and £800, will be tenable in the U.K. up to a period of two years. About five Fellowships will be available for Indian students.

The Fellowships will be available only to persons who hold recognized medical qualifications and whose talents and personal inclinations afford good promise of their ability to advance knowledge and education in some branch of medicine. Preference will be given to candidates who have served as medical officers with the armed and auxiliary forces of the countries. Particulars and application forms can be obtained from the Director-General, I.M.S., New Delhi.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for February-March, 1946. Patents from the Council of Scientific and Industrial Research are indicated by an asterisk.*]

32800. METAL CONSTRUCTIONAL COMPONENTS: *Made of ductile metal and provided with holes, slots and zones of relative weakness.*—Fcofix Ltd.
32934. SCREWED BOLTS: *Screwed bolt having its forward end provided with a portion which permits of its being driven into position in material.*—Applegate.
33044. LOW TEMPERATURE SEPARATION OF COMPRESSED GASEOUS MIXTURES: *Precooling the mixture through a heat interchange with mass of high boiling constituent sub-cooling and expanding it in a rectification zone.*—Indian Oxygen & Acetylene Co., Ltd.
33103. INTERNAL CLEANING OF TUBE-TYPE DETONATORS.—Popek.
33170. RECORDING OF SOUND ON FILM: *Recording film passed over the recording drum with the emulsion side facing the drum and recording light beam directed on to the emulsion side of the film.*—British Acoustic Films Ltd.
33202. A COLLAPSIBLE CARRIAGE: *The road wheels on opposite sides adapted to be swung upwardly away from one another.*—Charles Twigg & Co., Ltd.
33299. CLIPS OR CLAMPS FOR USE IN CONNECTING TOGETHER STRUCTURAL MEMBERS: *A clip or clamp comprising two U-shaped members joined back to back, and having hooked ends.*—Mills Scaffold Co., Ltd.
33387. IMPROVEMENTS IN AND RELATING TO ELECTRIC INCANDESCENT LAMPS: *Calcium fluoride to which has been added silica or alumina or other refractory oxide, is incorporated in the lamp getter mixture.*—Philips Lamps Ltd.
33433. PRINTING PLATES FOR ADDRESSING AND LIKE MACHINES: *Having a marginal extension for indexing or other inscription.*—Adrema Ltd. and R. L. Kerr.
33496. PROCESS FOR THE VERTICAL CASTING UNDER CENTRIFUGAL ACTION OF METAL BODIES WITH CORE-HOLES BY MEANS OF A MOULD AND A CORE: *A rotating mould and a stationary form-proof metal core, the core protected by a thin layer of a fire-proof substance.*—J. Suijk and K. Suijk.
30922. CRIMPING OR PLEATING: *Gripping the front and back ends of the necessary length of material drawing the gripping devices, withdrawing the back gripping device opening the front and feeding the material.*—Vokes Ltd.
31271. DRY PLATE RECTIFIERS: *Group of dry plate elements held together by thermoplastic material.*—G. E. Co., Ltd.
31279. STRANDS AND ROPES: *Formed by twisting two pairs of wires or strands.*—British Ropes Ltd.
31285. WATER-SEALS FOR DRAIN PIPES FROM WASH BASINS, KITCHEN SINKS AND LIKE INSTALLATIONS: *Seal provided with walls at least partly consisting of elastic material.*—Havrenious.
31333. DRYING MACHINE FOR PADDY OR LIKE CEREALS: *A series of endless belts arranged one above the other and heating elements which can be raised and lowered arranged within each belt.*—Ghatak.
31713. PERMANENTLY WAVING HAIR: *Winding hair to hollow curl and applying waving solution.*—Sales Affiliates Ltd.
31747. TELEPHONE OR LIKE SYSTEMS: *Permits toll break down facilities employing a line relay, a cut off relay and a non-numerical switch.*—Automatic Telephone & Electric Co., Ltd.
31775. VACUUM CLEANERS: *A shaped upper part and chassis in which are mounted the wheels and a brush, a motor and fan unit resiliently mounted, and a resilient connecting tube.*—G. F. Co., Ltd.
31787. STORAGE BATTERIES: *Plates built up of foils with battery paste built up on each side.*—Bowker.
31829. DETACHING OR PEELING SHELLS AND HUSKS FROM SEED OR GRAIN AND FOR REMOVAL OF COATING FROM COATED GRANULAR MATERIAL: *Repetitiously rubbing and rolling the grains against and between relatively moving attritive surfaces of highly frictional character under varying pressures.*—Continental Baking Co.
32046. VALVE EQUIPMENT: *Valve equipment involving use of a fluid operated pilot valve located close to the main valve, but operated by another control device located at a remote point.*—Grove and Grove.
32058. ALTERNATING CURRENT ELECTRIC SIGNALLING SYSTEMS: *A receiver for alternating current signals in which a signal is effective only if it persists for a certain minimum time.*—Standard Telephones and Cables Ltd.
32171. IRRADIATING FOOD AND ADVERTISING IT: *A method of subjecting food stuff to ultraviolet rays lethal to undesirable bacteria and at the same time exposing to the rays advertising matter provided with the food stuff which fluoresces under the ultraviolet rays.*—Abshire.
32172. PEST CONTROL COMPOSITIONS: *Ethers of di (hydroxyaryl) trichloromethyl methane are used as pest control compositions incorporated in a suitable carrier.*—F. I. du Pont de Nemours & Co.
32189. TURBO CHARGER DRIVE FOR THE INTERNAL COMBUSTION ENGINES OF MOTOR VEHICLES: *Turbo charger for supercharging internal combustion engines of motor vehicles.*—Bischof.
32451. MODIFICATION OF THE PROPERTIES OF ARTICLES DERIVED FROM NYLONS: *Nylon articles are subjected to a treatment with a crosslinking agent before subjecting them to the action of alcohol and formaldehyde.*—I.C.I. Ltd.
32480. DUPLICATING MACHINES: *Feeding paper by means of reciprocating frame and feed roller.*—Shourie.
32485. DUPLICATING MACHINE: *Stencil carrying drum mounted on hollow stands. Collapsible feed table and feed roller supported by bars which slide into the hollow stands.*—Shourie.

32549. ARTIFICIAL AQUEOUS DISPERSIONS OF NATURAL AND SYNTHETIC RUBBERS, RUBBER SUBSTITUTES AND RUBBER-LIKE SUBSTANCES: *Dispersing rubber by soap, an organic base, alkali silicate or borate.*—Dr. Talalay.
32576. CARBONACEOUS MATERIAL FROM CARBON MONOXIDE AND GASEOUS MIXTURES CONTAINING IT: *Continuous method for the production of carbon from carbonaceous material monoxide and gaseous mixture containing it comprises use of two reaction vessels, the carbonaceous material being maintained in the fluid state in both the vessels.*—I.C.I. Ltd.
32586. FRACTIONATING OF MIXTURES OF SOLID POLYMERS: *Solid polymers are fractionated by dissolving in organic gases at 500 atmospheres and at temperatures of 50° to 350° C. and then partially reducing the temperature and pressure.*—I.C.I. Ltd.
32601. SELF-HEATING FOOD CANS: *Heating food stuffs by generation of heat by chemical reaction of compact charge on ignition of an outside fuse.*—I.C.I. Ltd.
32724. TREATMENT OF WOOL AND OTHER PROTEIN FIBRES INCLUDING YARNS, WOVEN AND KNITTED TISSUES, FELT AND THE LIKE PRODUCED WHOLLY OR PARTLY THEREFROM TO RENDER THEM RESISTANT TO ATTACK BY MICRO-ORGANISMS: *Treating wool, etc., with ammoniacal solution of copper salt and chromate.*—Scapa Dryers Ltd. and Race.
32760. TUBULAR CONTAINERS FOR ELECTRICAL CONDENSERS OR OTHER ELECTRICAL APPARATUS: *Rectangular cross section reduced to form a circular aperture for a bung of resilient material and the edge being spun over to compress the bung.*—The Telegraph Condenser Co., Ltd.
32773. SELF-PRIMING CENTRIFUGAL PUMPING PLANT: *Combination of a centrifugal pump and a vortex pump for self-priming purposes, the vortex pump acting as a vacuum pump whilst priming and as a liquid pump in parallel with centrifugal pump after priming.*—Southern.
32788. HEAT EXCHANGE DEVICES: *Inserting reinforcing metal wire between adjoining elements in the rows near the header plates of the jointing medium and bonding by brazing.*—I.C.I. Ltd.
33145. NEW NITROSULPHONES: *Nitrosulphones from a reaction between nitroparaffin and an unsaturated or halogenated sulphone.*—I.C.I. Ltd.
28940. ADDITION AGENT FOR CAUSTIC ALKALI ELECTROLYTES USED IN THE PRODUCTION OF HYDROGEN AND OXYGEN: *Vanadium in soluble form is added to the electrolyte so as to reduce the operating voltage of the electrolytic cell.*—The Consolidated Mining and Smelting Co. of Canada, Ltd.
30110. INSECTICIDES: *Incorporating 1 to 1½ parts by weight of oxalic or phosphoric acid.*—Cooper, McDougall and Robertson, Ltd.
30835. INSECTICIDES (Addition to No. 30110): *Incorporating about 5 per cent. of sulphamic acid.*—Cooper, McDougall and Robertson, Ltd.
31523. NEW PYRIMIDINE COMPOUNDS: *Interacting a diamine with, 2 or 4 arylaminopyrimidine derivative.*—I.C.I. Ltd.
31524. NEW PYRIMIDINE COMPOUNDS: *Interacting arylamine with a 4 hydroxypyrimidine bearing in the 6 position a hydrocarbon radical and in the 2 position an aryl or alkylmercapto group.*—I.C.I. Ltd.
31525. NEW PYRIMIDINE COMPOUNDS: *Interacting 6 substituted 2 arylamino 4 hydroxypyrimidine with a halogenerating agent.*—I.C.I. Ltd.
32000. IMPROVING THE BONDING PROPERTIES OF TEXTILES: *Improving textiles by impregnating it in acidic aqueous solution of melamine formaldehyde and to cure it.*—American Cyanamid Co.
32545. NEW YELLOW AZO DYESTUFFS: *Cellulosic material is dyed with a dye prepared by heating a 4:4'-dibenzthiazyl-(2)-azobenzene with a tertiary base.*—I.C.I. Ltd.
32928. INSOLUBILISED FILAMENTARY PRODUCTS BY THE WET-SPINNING OF PROTEIN SOLUTIONS: *Stretching the coagulum in aqueous medium capable of swelling the coagulum, washing without relaxing the tension and finally treating the coagulum without the application of tension in an aqueous saline bath.*—I.C.I. Ltd.
32968. A SELF-ADJUSTING MECHANISM FOR HYDRAULIC WHEEL BRAKES: *Element consisting of two semi-circular pieces which embrace and are resiliently urged into engagement with abutments on the central rigid member.*—Taylor and Walker Engineering Co., Ltd.
33490. CUT-EDGED WOVEN ARTICLES SUCH AS CUT RIBBONS: *Passing the fabric between a rotating heated cutter disc and a rotating roller and bonding the severed edges.*—Charles Clay & Sons, Ltd., Clay and Heasman.
28461. PACK PARACHUTES: *Parachute canopy and shroud lines are stowed in container secured to aircraft.*—Quilter and Gregory.
29012. MOULD AND CORE CONSTRUCTION FOR CASTING COVERS FOR ELECTROLYTIC CELLS OF THE TANK TYPE: *A combined gas collector and a cell cover cast in one piece.*—The Consolidated Mining and Smelting Co. of Canada Ltd.
30433. HEAT EXCHANGE DEVICES: *Bonding member parts having coating of malleable silver copper alloy and heating to 780° C.*—I.C.I. Ltd.
30830. TREATMENT OF PAPER OR TEXTILE FABRICS WITH MONOMERIC POLYMERS: *Application of monomeric polymerisable compounds on textile fabric or paper, followed by their catalytic polymerisation thereon in partial or complete absence of oxygen.*—I.C.I. Ltd.
31376. GAS GENERATORS CHARGED WITH SOLID COMBUSTIBLE FUEL: *For withdrawing the gas and for introducing air into the coal on wood mass there are provided inserted pipes.*—Aktiebolaget Svenska Flaktfabriken.
31377. MEANS FOR REMOVING CHARCOAL DUST, CARBON PARTICLES AND LIKE DEPOSITS FROM A GAS-PURIFYING APPARATUS ASSOCIATED WITH A GAS GENERATOR FOR OPERATING AN INTERNAL COMBUSTION ENGINE: *A jet device combined with the purifier communicates with the exhaust pipe.*—Aktiebolaget Svenska Flaktfabriken.
31384. MEANS FOR CHANGING THE TRANSMISSION FREQUENCIES IN MULTI-CHANNEL SYSTEMS OF TELEPHONE OR TELEGRAPH TRANSMISSION: *Means for shifting the transmitted frequency band in the frequency spectrum.*—Skillman.
31496. KNITTING MACHINES AND KNITTED FABRIC: *Thread fed to and knitted by needles occupying a portion only and excluded from being knitted over the remainder of the needle circle.*—B. Toone (Nottingham) Ltd.
31528. TUNING ARRANGEMENTS FOR RADIO RECEIVERS: *Two frequency changers and amplifiers, the first having a wide band pass and the second a narrow band pass.*—Marconi's Wireless Telegraph Co., Ltd.
31619. PILE FABRICS: *Feeding an adhesive coated backing, conducting pile-forming element to it*

- and forcing the said elements to be embedded in the backing.—Victor.
32074. GAS ABSORPTION APPARATUS: Gas through porous glass to split into fine bubbles.—Rao.
- 32115 (OVEN) CHULHA FOR COOKING: Narrow mouthed Chulha with closed combustion chamber, wider mouth opening, air inlet and flue outlet provided.—Ram.
32513. COMPARISON OF FREQUENCIES: Gas discharge tubes arranged to be fired at the one frequency and to be quenched at the other frequency.—Standard Telephones and Cables Ltd.
32650. HOLLOW BUILDING UNIT FOR USE IN BUILDING OF FLOORS OR ROOFS OR OTHER CONSTRUCTIONAL PURPOSES: Having overhanging projection, and longitudinal re-enforcements embodied in the vertical walls and extending into the said projection.—Jhamb.
32943. DRAFTING MECHANISM FOR TEXTILE FIBRES: Each sliver to be drafted has allotted to it an individual second-line drafting roller mounted in a carrier.—The Indian Casablancas High Draft Co., Ltd., and Permyner.
33091. SPIRAL WOUND TUBING: Moving the sheet in a tubular path with edges of adjacent turns to form a flat seam and then sewing.—Spiral Bagging Machine Corp.
33165. LOCKS: Housing made of a series of laminations and shackle passing through the edges of the laminations.—Ahmed.
33271. WOOLLENISATION PROCESS FOR PRODUCING BLANKETS, BLANKET MATERIAL, FELT SUBSTITUTES AND CARPET MATERIAL: Mercerising jute for weft in the natural state by treatment with caustic agents.—Bird & Co.
33439. SHEARS, PRUNERS, AND LIKE CUTTING TOOLS: Arrangement of a member close to the auxillary cutters near the fulcrum, the member having a mouth adopted to hold the object to be cut at right angles to the plane of the cutters.—Caddy
31767. PYRAZINE DERIVATIVES: Heating the corresponding 3-carboxy derivatives in a decarboxylating solvent.—Merck & Co., Inc.
31768. PYRAZINE DERIVATIVES: Heating pyrazine derivatives in concentrated sulphuric acid.—Merck & Co., Inc.
31769. QUINOXALINE COMPOUNDS: Reacting alloxazine with a weak alkali to form a salt of 2-Amino-3-carboxy-quinoxaline.—Merck & Co., Inc.
31770. AMINO-PYRAZINES: Reacting a polynuclear organic compound containing a lumazine nucleus with mineral acid.—Merck & Co., Inc.
31771. PYRAZINE DERIVATIVES: Reacting a lumazine derivative with an alkali metal hydroxide in aqueous solution.—Merck & Co., Inc.
31772. PYRAZINE DERIVATIVES: Reacting a lumazine with an alkali metal hydroxide, in aqueous solution, recovering a free acid and decarboxylating such free acid.—Merck & Co., Inc.
31773. PYRAZINE DERIVATIVES: Reacting a lumazine in aqueous solution with alkali metal hydroxide.—Merck & Co., Inc.
31833. PUMPS FOR DELIVERING MEASURED VOLUMES OF LIQUID UNDER PRESSURE: Series of outlet ports and a chamber communicating with the cylinder.—Wedge.
32052. COMPOSITIONS FOR ADHESIVE OR SEALING PURPOSES: Comprising rubber, resinous material and organic solvent.—B. B. Chemical Co., Ltd.
32217. LAUNDERING OF WHITE TEXTILE ARTICLES: Washed articles are rinsed in an aqueous bath containing a fluorescent substance.—Lever Bros. and Unilever Ltd.
32218. WHITENESS OF WHITE TEXTILE MATERIALS: Rinsing the material in an aqueous bath containing a blue fluorescent substance.—Lever Bros. and Unilever Ltd.
32252. AGEING SOLUTIONS OF COLLOIDAL MATERIAL: Passing solution at regular rate through heated Zone, the Zone being heated by means and controlled by variations in viscosity.—I.C.I. Ltd.
32322. MANHOLE AND INSPECTION COVERS AND FRAMES: Hinged members carrying securing means for removably attaching to cover and frame with the hinge axis lying above the joint line between the cover and the frame.—Elkington.
32450. NEW MONOAZO DYESTUFFS: Monoazo dyestuffs are prepared by coupling p-nitraniline with sulphuric ester of N-alkyl (C₁-C₈)-N-hydroxyalkyl (C₂-C₆)-aniline.—I.C.I. Ltd.
32771. DERIVATIVES OF β -ERYTHROIDINE: Hydrogenating β -erythroidine and acid salt or hydrohalide in presence of catalyst.—Merck & Co., Inc.
33163. LOCKS PARTICULARLY CYCLE LOCKS: Laminated housing, hooked lever, locking lever and spring.—Ahmed.
33300. ELECTRIC FANS: Fan and its driving motor are carried upon one end of an arcuate bracket which is clamped to a pedestal.—Berkely and Young Limited and Grundon.
33379. A CALCIUM BASE MINERAL OIL GREASE: Calcium hydrogenated oil soap in mineral oil.—R. V. Briggs & Co., Ltd.
29137. SCREW PILES AND CYLINDERS: Screw head driven by a hollow cylindrical mandrel within which a permanent concrete pile is placed prior to its withdrawal.—Braithwaite & Co. (India) Ltd.
29138. SCREW PILES AND CYLINDERS: Screw head is provided with jetting and/or air lift liquid discharge facilities so that the interior of the mandrel is sealed from bore hole.—Braithwaite & Co. (India) Ltd.
29819. RANGEFINDERS, HEIGHTFINDERS, AND LIKE OPTICAL MEASURING INSTRUMENTS OPERATING ON THE COINCIDENCE PRINCIPLE: Portion of the two beams which are not directed to one of the two eyepieces from the transmitting and reflecting screen are directed therefrom to the other eyepiece.—Bart & Stroud, Ltd.
29820. RANGEFINDERS, HEIGHTFINDERS, AND LIKE OPTICAL MEASURING INSTRUMENTS OPERATING ON THE COINCIDENCE PRINCIPLE: The Prism arranged at such an angle that for both beams partial internal reflection at nearly the critical angle and partial transmission of the light takes place.—Bart & Stroud, Ltd.
30592. LIQUID CONTAINERS: Fuel containing envelope having internal structure and external protective covering.—I.C.I. Ltd.
30876. AROMATIC DERIVATIVES OF TRICHLOROETHANE: Interacting chloral alcoholate with aromatic compounds.—I.C.I. Ltd.
31359. SULPHUR OR SULPHURIC ACID: Converting calcium sulphate into calcium sulphide, which in turn is converted into hydrogen sulphide, then hydrogen sulphide into sulphur or sulphuric acid.—Morarji.
31360. CEMENT: Converting calcium sulphate into calcium sulphide which in turn is converted into calcium carbonate then calcium carbonate into cement.—Morarji.

31633. TREATMENT OF HYDROCARBONS: *Admixing Hydrocarbons with liquid hydrogen fluoride containing boron fluoride under pressure.*—The Standard Oil Co.
31721. TELEPHONE SYSTEMS: *Exchange equipment controlled by calling party, local calls set up automatically and for out calls connection extended to operator at the other exchange.*—Automatic Telephone & Electric Co., Ltd.
31736. LAMP BASES: *Metal disc contact of lead in wire fusion sealed to glass bead over apertures in metal plates fusion sealed to envelope ends.*—International General Electric Company of New York, Ltd.
31737. ELECTRICAL DEVICES HAVING TUBULAR ENVELOPES OF VITREOUS MATERIAL: *Rounded longitudinal edges of flat tubes put in pre-compression strain by chilling in advance of the walls from temperature above strain point.*—International General Electric Company of New York, Ltd.
31796. ENGINE LATHES: *Two lathe carriages bearing cross-slides are each directly engageable either to a threaded feed shaft or to a power screw.*—Mackintosh-Hemphill Co.
31873. COMPOSITE FABRIC: *Woven base fabric and knit fabric.*—Vanity Fair Mills, Inc.
31879. BREAKING THE CRUST ON AN ALUMINIUM REDUCTION POT OR THE LIKE: *Pile driving device having a heavy plunger arranged to be lifted by a driving mechanism and falling under gravity to break the crust in aluminium reduction cells.*—Aluminium Laboratories Ltd.
31880. BREAKING THE CRUST ON AN ALUMINIUM REDUCTION POT OR THE LIKE: *Crust breaking device for aluminium cell or pot pneumatic pavement breaker mounted on a beam suitably for operation.*—Aluminium Laboratories Ltd.
31891. KNITTING MACHINE NEEDLES AND MEANS FOR OPERATING SAME: *Needle having a hook and a tongue having a hook-closing portion located within the needle-hook.*—Vanity Fair Mills, Inc.
31999. ELECTRIC CONTROL APPARATUS FOR PLACING A LOAD IN A SELECTED ONE OF A PLURALITY OF PREDETERMINED POSITIONS: *Electric Control apparatus for placing a useful load in a predetermined position.*—Yardeny.
32036. COMPOSTING AGRICULTURAL WASTE PRODUCTS AND OBTAINING A FERTILISER FROM LEGUMINOUS PLANTS: *Barrel divided into compartments having covers and vent tubes.*—Abbot.
32147. ADIPIC ACID: *By the oxidation of cyclohexanone, cyclohexanol or a mixture of cyclohexanone and/or cyclohexanol with nitric acid in the presence of both vanadium and copper either as such or their oxides or salts.*—I.C.I. Ltd.
32289. VACUUM PACKAGING: *Blanks received in magazines are withdrawn, deposited in moulds, opened, filled and vacuum sealed.*—The Flexible Vacuum Container Corp.
32444. DRAWING OR DRAFTING MECHANISMS FOR TEXTILE SLIVERS: *Comprising several pairs of rollers, a conducting roller, a frame and a condenser.*—Solanas.
32528. SAFETY RAZORS: *A co-operating cap and guard members with a leaf spring having a blade-engaging portion, interposed between them.*—Gillette Safety Razor Co.
32660. CATALYTIC HYDROGENATION OF ORGANIC COMPOUNDS: *Activating nickel-aluminium alloy catalyst with dilute caustic alkali for hydrogenation organic compounds.*—E. I. Du Pont de Nemours & Co.
32661. CALCINING OR SINTERING: *Unitary kiln structure for preheating, calcining and cooling calcined material.*—Kennedy.
32666. NEW POLYMERIC THIOLCARBOXYLATES: *Reacting a thiolcarboxylic acid with a linear polymer having ethylenically unsaturated substituents.*—E. I. Du Pont de Nemours & Co.
32715. BLEACHING TEXTILE GOODS: *Comprising in combination, a heating tube, a storage chamber and a washing chamber.*—E. I. Du Pont de Nemours & Co.
32718. TELEPHONE EXCHANGE SYSTEMS: *Lines are divided into groups, plurality of linefinders divided into corresponding groups. Initiation of call corresponding line finders actuate.*—Standard Telephones and Cables Ltd.
32753. CASINGS FOR ELECTRICAL CONDENSERS OR OTHER ELECTRICAL APPARATUS: *The internal beading on the tubular casing of an electrical condenser is interrupted, the interruptions being engaged by projections on the closure disc which is thus prevented from rotating.*—The Telegraph Condenser Co., Ltd.
32756. TUBULAR CONTAINERS FOR ELECTRICAL CONDENSERS OR OTHER ELECTRICAL APPARATUS: *Reducing a portion at the end of a tubular metal container to form a neck of cylindrical shape to grip a bung of resilient material.*—The Telegraph Condenser Co., Ltd.
32757. TUBULAR CONTAINERS FOR ELECTRICAL CONDENSERS OR OTHER ELECTRICAL APPARATUS: *Lining of resilient material inserted in the open ends of tubular metal container which is flattened to lining the opposite sides of the former into contact.*—The Telegraph Condenser Co., Ltd.
32758. TUBULAR CONTAINERS FOR ELECTRICAL CONDENSERS OR OTHER ELECTRICAL APPARATUS: *The closure, a disc of resilient material retained between spun-over edge of the tube and the apparatus within the tubular container.*—The Telegraph Condenser Co., Ltd.
32762. VOLTAGE STABILISING CIRCUITS: *Cathode-grid circuit of control valve includes part of resistances in series, connected parallel to load; provision, for varying the fraction of output voltage applied to the grid, made.*—The Mullard Radio Valve Co., Ltd.
32835. BLEACHING OF COTTON GOODS: *Cotton goods are brought into contact with an aqueous solution of a peracid and subsequently with an aqueous solution of a peroxygen compound.*—E. I. Du Pont de Nemours & Co.
32957. MAGNETIC DUST CORE: *Containing a 1 to 1.25 per cent. of an inorganic binding mixture of talc, magnesium hydroxide, sodium silicate and a high molecular weight organic material phenol formaldehyde resin, in 1 to 10 per cent. of the inorganic insulating material.*—Standard Telephones and Cables Ltd.
33063. BELTING: *Knitted fabric impregnated in rubber latex or solution, stretched and allowed to dry; warmed to plasticise rubber and cured under heat and pressure.*—George Angus & Co., Ltd.
33104. HEEL FOR FOOTWEAR: *Comprising two metal plates carrying springs inside.*—Mohanlal.
33146. RECTILINEAR MACHINE BELT FASTENER: *Two plate like members having serrations urged to grip by a bolt passing through them.*—Loewenthal.
33200. A FREE WHEEL FOR CYCLES AND THE LIKE VELOCIPEDES: *End plate ring fitted on a collar, having an inwardly sloping face on the ring secured on the hub of the rear wheel, flanges*

- on both sides of the toothed wheel.—Ahmed Din.
33254. ELECTRIC FUSE DISTRIBUTION BOXES: *Interchangeable and reversible connector, fittings for clamps for phase conductors, laterally projecting offsets integral with fittings for clamping conductors connected to fuses.*—W. T. Henley's Telegraph Works Co., Ltd.
33257. MACHINES FOR PERFORMING LASTING OR ANALOGOUS OPERATIONS UPON SHOE PARTS: *Lasting machine with gripper means for seizing margin of stock to be lasted over shoe-bottom engaging means, in a direction parallel to the bottom of the shoe.*—The British United Shoe Machinery Co., Ltd.
33269. 2-CHLOROPYRAZINE: *Reacting a mixture of chlorine and Pyrazine.*—American Cyanamid Co.
33301. LEAF, PAPER OR THE LIKE CUTTING MACHINES: *Leaf is cut by combined action of punch supported by set of levers and set of shearing blades mounted on table.*—Chatterjee and Chatterjee.
33365. TELEPHONE SYSTEMS: *Local calls automatically extended to tandem exchange where the operator's switch enables operator to select an incoming selector. Out calls controlled by operator.*—Automatic Telephone & Electric Co., Ltd.
33366. TELEPHONE SYSTEMS: *Finder switches selected by step by step allotter which operates by self-interruption at speed allowing finding operation.*—Automatic Telephone & Electric Co., Ltd.
33408. WASHING AND DRYING MACHINES: *Comprising washing means, mechanism for operating the washing means, a motor for driving the mechanism, an oil pump, a friction clutch between the motor and the mechanism and a bellows supplied from the oil pump characterised by means controlled by the clutch torque.*—International General Electric Co., Inc.
33614. SUCTION CLEANERS: *Surface cleaning tool comprising nozzle member connected to source of suction and brush and wheels to engage the surface.*—Hoover Ltd.
- *33786. IMPROVEMENTS IN THE WORKING LIFE OF JUTE OR COTTON MILL BOBBINS, TEXTILE SHUTTLES OR THE LIKE ACCESSORIES MADE OF WOOD: *Soaking the articles in a varnish composed of drying or semi-drying oil and shellac and drying the treated article.*—Sir Bhatnagar, Dr. Verman, Dr. Karim and Nayer.
28804. BINOCULAR TELESCOPE INSTRUMENTS: *Objective axes of the two Optical systems inclined to one another.*—Barr & Stroud, Ltd.
28805. CEMENTING TOGETHER OF OPTICAL PARTS: *By a thin film of transparent flexible material, e.g., cellulose or synthetic resin.*—Barr & Stroud, Ltd.
29813. OPTICAL OBSERVATION INSTRUMENTS: *A flexible water-proof tubular sealing member forms impervious cover over the junction of the sliding parts.*—Barr & Stroud, Limited.
29990. REMOVAL OF METAL WIRE FROM VULCANISED RUBBER SUCH AS THE RIMS OF TYRE COVERS: *Heating contact surface, pulling away the wire.*—Cotton.
30452. PURIFICATION OF MAGNESIUM CHLORIDE: *Causing precipitation of the soluble metal impurities which are below magnesium in the electromotive series of the elements.*—The Consolidated Mining and Smelting Co. of Canada, Ltd.
30849. FUEL CONTAINERS: *Flexible non-metallic pieces tailored to inner surface of outer wall forming internal flange-like portions for supporting baffles.*—I.C.I. Ltd.
31137. CONVERSION OF CASHEW NUT SHELL OIL INTO A HARDENED PLASTIC PRODUCT: *Cashew nut shell liquid is treated with an alkaline earth metal oxide or hydroxide.*—General Foods Corpn.
31551. WINDING STRIP-SHEET MATERIAL, SUCH AS MOTION PICTURE FILM: *A reel in combination with belting having a plurality of endless belts, one for each path.*—Technicolor Motion Picture Corpn.
31932. ACETYLENE GENERATORS: *A vibratable diaphragm controlled feed valve for carbide activated by a pulsating gas pressure.*—The Sight Feed Generator Co.
31953. COMPOSITIONS CONTAINING VULCANISED OIL AND RESIN: *Oil containing resin is vulcanised and admixed with a hydraulic cement.*—Semtex Ltd.
31956. HEELING OF SHOES OR FASTENERS SUITABLE FOR USE THEREIN: *Fastener having similar end portions, one end being clenched inside the shoe and the other deformed before entry into the heel.*—The British United Shoe Machinery Co., Ltd.
32229. HEAT EXCHANGE SYSTEMS: *Heat exchange takes place between the comparatively high pressure ventilating air and hot gases or partially cooled gases.*—I.C.I. Ltd.
32311. INSECTICIDAL COMPOSITIONS: *Comprising a paralyzant and alpha: alpha-di (parachlorophenyl) beta: beta: beta-trichloroethane.*—E. I. Du Pont de Nemours & Co.
32340. RAMIE HARVESTING AND DECORTICATING MACHINE: *Wheeled box, rigid crusher member, spaced rotary scrapers, corrugated rollers, cutting means and conveyors.*—Breton.
32452. MODIFICATION OF THE PROPERTIES OF ARTICLES DERIVED FROM NYLONS: *Articles derived from a nylon are heated in presence of an alcohol, formaldehyde and for polyoxymethylene or paraformaldehyde and a catalyst, until the nylon contains 4 per cent. of combined formaldehyde.*—I.C.I. Ltd.
32472. SYNTHETIC LINEAR POLYAMIDE ARTICLES: *Polyamide yarns on fabrics are impregnated with a resin formed from an aldehyde and catechol or a resin-forming derivative.*—E. I. Du Pont de Nemours & Co.
32543. PACKAGES: *Tubular section of flexible sheet is flattened and sealed in perpendicular planes at opposite ends to produce tetrahedron shape.*—Rausing.
32598. DRAFTING APPARATUS FOR DRAWING, SPINNING AND LIKE TEXTILE MACHINES: *A guide of U-section having its flanking sides progressively spaced closer together from entry point.*—Howard & Bullough Limited, Hunter, and Rushton.
32691. FERROMANGANESE BY ALUMINO-THERMIC PROCESS: *Alumino-thermic process, where roasted ferro-manganese with aluminium turnings reacted and melted with slag forming materials and fluxes.*—Thermolloys Ltd.
- *32823. RAISED PATTERNS OR LETTERING ON THE SURFACE OF PLASTIC MOULDED PRODUCTS: *Plastic substance under pressure caused to flow into engraved regions containing dry colouring material.*—Sikka, Singh and Dr. Verman.
- *32824. CONTAINERS, HOLLOW-WARE OR THE LIKE ARTICLES FROM RESIN IMPREGNATED LAMINATIONS: *One of the co-acting mould parts is provided with a spring loaded pilot plunger.*—Sikka, Singh and Dr. Verman.

STUDIES IN THE ALKALOIDS OF *CASSIA ABSUS* LINN.—PART I

By VISHWA NATH PURI, VISHWA NATH SHARMA and SALIMUZZAMAN SIDDIQUI

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SIDDIQUI and Ahmad¹ who isolated chaksine from the seeds of *Cassia absus* Linn. tentatively assigned to it the formula $C_{12}H_{21}O_2N_3$. As the free quaternary base was not available in a pure form due to the avidity with which it absorbs carbon dioxide from the atmosphere, the authors based their provisional formula on the results of analysis of the bicarbonate and the chloro-platinate before and after drying at 100° C. in vacuo. Kapur, Gaiind, Narang and Ray² suggested an alternative formula $C_{11}H_{21}O_3N_3$ for chaksine in support of which they recorded the analytical results of the iodide, sulphate, chloride, bromide and the nitrate. While admitting the eventual possibility of slight alterations in their provisional molecular formula as a result of future work on the constitution of the base, Siddiqui and Ahmad³ advanced reasons to show that the results embodied in Ray *et al's* communication did not justify a change in the molecular formula for chaksine at this stage. The present paper deals with the results of further investigations which were greatly facilitated by the finding that chaksine-bicarbonate, a useful starting material for these investigations, can be easily obtained by the double decomposition of chaksine-iodide with an aqueous solution of potassium-bicarbonate.

Benzoylation of chaksine-bicarbonate after Schotten-Baumann results in the formation of a crystalline neutral product (m.p. 273° C.) and a micro-crystalline powder (m.p. 183–84° C.) besides traces of a base obtained from the acid washings of the reaction product through precipitation with ammonia. The *macro* results of the crystalline product (found C, 69.7, 69.4; H, 6.7, 6.4; N, 9.6) indicate it to be the benzoyl-benzoate of chaksine with the C_{12} formula ($C_{12}H_{19}O_2N_3 \cdot (C_6H_5CO)_2$ requires C, 69.8; H, 6.5; N, 9.4). It may, however, be noted that while the N-values of *micro-analyses* carried out by Weiler and Strauss (found N, 9.1) agrees with this formula, their carbon and hydrogen values (found C, 68.5; H, 5.7) are too low for it and might indicate

a di-benzoyl-benzoate with the C_{11} formula ($C_{11}H_{18}O_3N_3 \cdot (C_6H_5CO)_3$ requires C, 69.2; H, 5.9; N, 7.6) if it were not for the fact that both the *macro* and the *micro* N-values are about 2 per cent. higher than required and, therefore, exclude such a formulation. Benzoylation of chaksine-iodide under identical conditions, which one of the authors (S.S.) had previously carried out, had also yielded a similar product (m.p. 268° C.) and the results of micro-analysis carried out by Schoeller before the war (found C, 68.9; H, 6.2; N, 9.1), were in general agreement with the *macro* results of the present product. The analytical data of the micro-crystalline product referred to above, show it to be the hydrate of the mono-benzoyl-benzoate according to the C_{12} formula, with half a molecule of water of crystallization (found after drying at 58° C. in vacuo over P_2O_5 , C, 68.3; H, 6.2; N, 9.6, 9.2; $C_{12}H_{19}O_2N_3 \cdot (C_6H_5CO)_2 \cdot \frac{1}{2} H_2O$ requires C, 68.4; H, 6.6; N, 9.2; $C_{11}H_{18}O_3N_3 \cdot (C_6H_5CO)_3 \cdot \frac{1}{2} H_2O$ requires C, 68.0; H, 6.0; N, 7.4). On drying it in vacuo at 100° C. it is slowly converted into the higher melting benzoyl-derivative, but the process of dehydration, particularly at higher temperatures, is accompanied by partial degradation of the product whereby benzoic acid, benzaldehyde and a nitrogen-containing acid are formed.

Along with studies in benzoylation attempts were also made to prepare a series of organic acid salts of the base, as the analyses of these salts would be free from the objections, raised by Siddiqui and Ahmad (*loc. cit.*) against deriving the molecular formula of an alkaloid from the analytical data of its high melting sulphates and halogen salts. The preparation of these salts was carried out by warming chaksine-bicarbonate with an excess of an aqueous solution of the acid or by dissolving the carbonate in alcoholic acid solution and precipitating the salt with ether. By either of these methods the acetate, tartrate, oxalate, succinate and the citrate could be obtained in a crystalline form. Out of these salts the acetate and the tartrate

are neutral in character, whereas the oxalate, succinate and the citrate are acidic and give vigorous evolution of carbon-di-oxide when treated with bicarbonate solution. Benzoic acid, on the other hand, appears to give a mixed salt—a carbonate-benzoate—which evolves carbon dioxide on treatment both with acid and bicarbonate solutions. The formation of acid salts with comparatively stronger acids indicated the presence of a feebly basic nitrogen, the existence of which was suggested by Siddiqui and Ahmad (*loc. cit.*) on the basis of the analytical data of the Pt-salt of chaksine. The presence of the second basic nitrogen was finally proved through the preparation of a crystalline, acidic chaksine-disulphate (m.p. 197° C.). This salt is extremely susceptible to hydrolysis in aqueous or hydroxylic solvents, thereby getting converted to the normal sulphate (m.p. 316° C., decomp.), but it is quite stable in 5 per cent. alcoholic sulphuric acid and can be precipitated out from the solution with ether.

In contrast to the results of analyses of the benzoyl-derivatives, the analytical data of these salts, particularly the nitrogen values, are definitely more in favour of the C_{11} formula. It may, however, be noted in this connection that during the present investigations a number of workers independently obtained higher carbon values in *macro* estimations, agreeing with the C_{12} formula for some of the salts. Taking all the facts into consideration, it would not, therefore, appear altogether safe at the present stage of investigations to reject the C_{12} formula for chaksine, and conclusive evidence in this connection will have to await the results of studies in the degradation products of the base. Work in this direction is in progress and it may be mentioned that we have already been able to obtain a water-soluble crystalline base, a cyanide with a characteristic caraway like odour, a neutral crystalline product and the ammonium salt of a crystalline acid through the thermal decomposition of chaksine salts. The action of concentrated nitric acid on chaksine nitrate has further yielded the crystalline nitrate of a base melting at 170° C. and answering to the formula $C_9H_{17}ON_2NO_3$ along with a crystalline acid. The results of these studies will be dealt with in a subsequent communication.

Experimental

Chaksine-bicarbonate.—A cold saturated solution of potassium bicarbonate was

slowly added to a concentrated solution of chaksine iodide (1 gm.) in methanol with constant stirring. The white crystalline precipitate was filtered, washed with water and then with methanol. On recrystallization from a 3 per cent. bicarbonate solution, chaksine-bicarbonate came out in the form of long, white, silky needles which after washing with water and drying in air softened at 169° C. and melted with frothing at $177-79^{\circ}$ C.; yield 0.7 gm. It is soluble in dilute bicarbonate solution in the hot, but almost insoluble in water or organic solvents.

Benzoylation of Chaksine-Bicarbonate.—12 cc. of benzoyl chloride was added drop by drop to 14.2 gms. of the bicarbonate taken up in 100 cc. of 20 per cent. aqueous caustic soda and vigorously shaken, the temperature throughout being kept below 5° C. The resultant cream-coloured powder was filtered, repeatedly washed with cold water and dried on a porous plate. The amorphous product thus obtained (18.1 gms.) melted at 224° C. with previous softening at $90-100^{\circ}$ C. and frothing at 130° C. It was repeatedly extracted with 3-4 per cent. acetic acid in the cold and the acid solution neutralized with ammonia when a white, crystalline precipitate (0.45 gm.) melting indefinitely between $100-126^{\circ}$ C. with softening and shrinking at 80° C. separated out. After repeated crystallization from dilute alcohol the base was finally obtained in the form of cauliflowerlike aggregates of white needles which soften at 112° C., shrink at 122° C. and give a miniscus at $146-52^{\circ}$ C. The mother liquors on concentration gave a minute quantity of an oily base which crystallized from petrol ether in long, colourless, thick rods (m.p. 116° C.) and some unchanged chaksine (0.75 gm.) which was isolated through the iodide.

The acid insoluble residue obtained above was taken up in ethyl acetate and the solution washed with dilute bicarbonate solution. The bicarbonate washings yielded benzoic acid on acidification. The ethyl acetate solution was finally washed with water, dried over sodium sulphate and kept overnight in the cold when clusters of white, glistening needles (0.65 gm.) melting at 263° C. separated out. The mother liquors yielded another crop (0.6 gm.) of the same product on concentration. The syrupy residue left on evaporation of the solvent from the final mother liquors gave on repeated fractionation with ether and petrol ether,

an ether soluble fraction (5.5 gms.) melting at 183-84° C. after softening at 85-95° C. and shrinking at 135-45° C. and a number of intermediate fractions which melted indefinitely between 200-254° C. and were apparently mixtures of the higher and the lower melting benzoyl derivatives.

Chaksine-benzoyl-benzoate.—On repeated crystallization of the higher melting product (total 1.25 gms.) from a mixture of chloroform and benzene, 1.1 gms. of the pure benzoyl derivative was finally obtained in the form of white, shining clusters of needles melting at 273° C. It is readily soluble in chloroform, sparingly soluble in benzene and ethyl acetate and insoluble in other organic solvents and in water. In 1 per cent. chloroform solution it gave $[\alpha]_D^{36} = +15.9^\circ$. Found after drying to constant weight at 100° C. in vacuo over P_2O_5 , C, 69.7, 69.4, 68.5*; H, 6.7, 6.4, 5.7*; N, 9.6, 9.1*; $C_{12}H_{19}O_2N_3(C_6H_5CO)_2$ requires C, 69.8; H, 6.5; N, 9.4; $C_{11}H_{18}O_3N_3(C_6H_5CO)_3$ requires C, 69.2; H, 5.9; N, 7.6.

The ether soluble lower melting product is a micro crystalline white powder, insoluble in petrol ether, readily soluble in ether and other organic solvents. In 1 per cent. chloroform solution it showed $[\alpha]_D^{36} = -29^\circ$. On drying to constant weight at 58° C. in vacuo over P_2O_5 , it lost 0.85 per cent. in weight, (m.p. unchanged) and gave C, 68.3, 68.7; H, 6.2, 6.2; N, 9.6; $C_{12}H_{19}O_2N_3(C_6H_5CO)_2 \cdot \frac{1}{2}H_2O$ requires C, 68.4; H, 6.6; N, 9.2; $C_{11}H_{18}O_3N_3(C_6H_5CO)_3 \cdot \frac{1}{2}H_2O$ requires C, 68.0; H, 6.0; N, 7.5 per cent. On keeping in vacuo at 100° C., it melts to a light brown liquid with continuous loss in weight which after 40 hours amounted to a total of 10.1 per cent., without arriving at a constant figure. The molten liquid yielded the higher melting benzoyl derivative on rubbing with acetone in the cold.

5.2 gms. of the benzoyl hydrate in small fractions was kept at 225° C. in a carbon dioxide atmosphere at 6-7 mm. pressure till the frothing had stopped (45 minutes). The residue on keeping in acetone in the cold gave a crystalline product (0.5 gm.) melting at 263-64° C., which after recrystallization from chloroform, benzene mixture melted at 273° C. and was found to be identical with the higher melting benzoyl derivative referred to above. The distillate gave (1) a neutral light brown oil having a characteristic caraway-like odour, (2) benzaldehyde, (3)

benzoic acid and (4) a nitrogen containing acid melting at 127° C.

Chaksine-acetate: 1.5 gms. of the bicarbonate was dissolved in 1.2 cc. of glacial acetic acid and ether added to the solution. The oily precipitate was repeatedly washed with ether, dissolved in acetone and the solution kept in the cold when the acetate crystallized out in colourless rods and needles, which after repeated washing with ether melted at 210° C. After a few crystallizations from alcohol-ether mixture, it softened at 213° C. and melted to a light brown liquid at 216° C.; yield, 1.3 gm. In 1 per cent. aqueous solution it showed $[\alpha]_D^{28} = +32.5^\circ$. Found after drying to constant weight at 100° C. in vacuo over P_2O_5 , C, 55.8, 55.8, 54.5, 54.5, 54.9*; H, 7.9, 8.2, 8.1, 8.3, 8.2*; N, 15.3*; $C_{11}H_{20}O_2N_3 \cdot CH_3COO$ requires C, 54.7; H, 8.1; N, 14.7; $C_{12}H_{20}ON_3 \cdot CH_3COO \cdot CH_3COOH$ requires C, 56.3; H, 7.9; N, 22.3 per cent.

Chaksine-tartarate: was obtained through the decomposition of chaksine-carbonate with an aqueous concentrated solution of tartaric acid in the hot. It crystallizes out of water in long, snow-white, silky needles which darken at 286° C. and melt at 288° C. It is a neutral salt and, like the acetate, it does not give carbon dioxide with dilute bicarbonate solution. In 0.33 per cent. aqueous solution it showed $[\alpha]_D^{29} = +37^\circ.5$. Found after drying to constant weight at 100° C. in vacuo over P_2O_5 , C, 51.9*; H, 6.6*; N, 13.6*; $(C_{11}H_{20}O_2N_3)_2(CHOH.COO)_2$ requires C, 52.0; H, 7.3; N, 14.0; $C_{12}H_{20}ON_3 \cdot COO(CHOH)_2COOH$ requires C, 51.75; H, 6.7; N, 11.3 per cent.

Chaksine-oxalate: separated out in the form of snow-white, long, silky, needles when chaksine-bicarbonate was treated with an excess of aqueous oxalic acid. When crystallized from 2 per cent. solution of oxalic acid, washed with water and dried in air, it finally melted at 311° C. (decomp.). On recrystallization from water the melting point is progressively lowered, apparently as a result of partial hydrolysis. The salt is insoluble in ether or acetone, sparingly soluble in alcohol or water in the cold but is fairly soluble in the hot. With bicarbonate solution it shows brisk evolution of carbon dioxide. Found after drying to constant weight at 100° C. in vacuo over P_2O_5 ,

Values marked * are those obtained by Weiler and Strauss.

C, 50.0, 50.0, 49.7*; H, 7.1, 7.1, 6.6*; N, 13.0*; $(C_{11}H_{20}O_2N_3COO)_2(COOH)_2$ requires C, 49.5; H, 6.7; N, 13.3; $(C_{12}H_{20}ON_3COO)_2(COOH.COOH)_2$ requires C, 50.6; H, 6.2; N, 11.8 per cent.

Chaksine-succinate: was obtained in a similar manner as the oxalate. On recrystallization from water it separated out in the form of long, white, silky needles which soften at 217° C. and melt at 219° C. The succinate is fairly soluble in hot water, less so in the cold, sparingly soluble in alcohol and insoluble in other organic solvents. Like the oxalate, it is also an acid salt and liberates carbon dioxide with bicarbonate solution but it is comparatively more stable and its melting point is not affected on recrystallization from boiling water. In 1 per cent. aqueous solution it showed $[\alpha]_D^{29} = +37.5$. Found after drying to constant weight at 100° C. in vacuo over P_2O_5 , C, 52.0, 52.5*; H, 7.2, 7.4*; N, 11.5*; $(C_{11}H_{20}O_2N_3COO.CH_2)_2(CH_2COOH)_2$ requires C, 52.5; H, 7.3; N, 12.2 per cent.

Chaksine-citrate: was prepared in the same manner as the oxalate. After repeated crystallizations from 1 per cent. citric acid solution it was obtained as colourless shining rods and plates which after washing with water and drying in air froth at 235° C. The citrate also is an acid salt and on crystallization from water its behaviour is similar to that of the oxalate in respect of deterioration in melting point. Found after drying at 100° C. in vacuo over P_2O_5 to constant weight, C, 52.4*; H, 7.0*; N, 12.3* per cent.

Chaksine-carbonate-benzoate: 1.1 gm. of chaksine-bicarbonate in alcoholic suspension was treated with an ethereal solution of benzoic acid and the pasty mass formed was repeatedly washed with ether. The residue on being rubbed with cold acetone crumbled to a crystalline powder which softened at 95-100° C., began to shrink at 150° C. and melted at 202° C. From an alcohol ether acetone mixture the salt came out in colourless clusters of needles which were readily soluble in alcohol or methanol, fairly soluble in water, insoluble in ether and melted at 205° C. with previous softening and shrinking. With dilute acetic acid or bicarbonate solution it showed brisk evolution of carbon dioxide. After drying to constant weight at 100° C. in vacuo over P_2O_5 it gave, C, 60.8, 60.9; H, 8.0, 7.4 per cent.

Chaksine-acid-sulphate: 1 gm. of chaksine carbonate in 10 cc. of 25 per cent. alcoholic

sulphuric acid was warmed on the water bath till a clear solution was obtained. The crystalline precipitate which separated out on addition of ether to the solution was filtered and repeatedly crystallized from 5 per cent. alcoholic sulphuric acid and ether, when the salt was finally obtained in colourless, prismatic rods which after washing with acetone and ether melted at 197° C. with previous softening at 189° C.; yield 0.95 gm. The disulphate could also be obtained by crystallization of the normal chaksine sulphate (m.p. 316° C., decomp.) from a mixture of 25 per cent. alcoholic sulphuric acid and ether. In marked contrast to chaksine-sulphate, the acid sulphate is exceedingly soluble in water. The double salt, however, is hydrolysed on dilution of its concentrated solution, yielding the insoluble normal sulphate. It is soluble in methanol but insoluble in acetone or ether. After drying to constant weight at 100° C. in vacuo over P_2O_5 it gave, S, 9.8, 9.7 (direct precipitation with $BaSO_4$); $(C_{12}H_{20}ON_3)_2SO_4.H_2SO_4$ requires S, 10.0 per cent.

0.1698 gm. of the salt on being hydrolysed with water gave 0.1349 gm. of the normal salt. The filtrate and washings from this estimation gave 0.0606 gm. of $BaSO_4$ equivalent to 15.0 per cent. of H_2SO_4 ; $(C_{12}H_{20}ON_3)_2SO_4.H_2SO_4$ requires $(C_{12}H_{20}ON_3)_2SO_4$, 84.6; H_2SO_4 , 15.4 per cent. The normal sulphate from the same estimation (0.1349 gm.) was dissolved in hot water and precipitated with $BaCl_2$ when it gave $BaSO_4$, 0.0593 gm. corresponding to S, 5.9; $(C_{12}H_{20}ON_3)_2SO_4$ requires S, 5.9 per cent.

Chaksine-chloride and the iodide prepared in a similar manner as the sulphate are colourless, silky needles which melted at 176° C. and 169° C., after drying in air, and in 1 per cent. aqueous solution showed $[\alpha]_D^{29} = +36.5$ and $[\alpha]_D^{29} = +32.0$ respectively. Attempts to prepare the corresponding di-salts were not successful.

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References

- 1 Siddiqui, S., and Ahmad, Z., *Proc. Ind. Acad. Sci.*, 1935, 2, 421.
- 2 Kapur, Gaiand, Narang and Ray, *J. Ind. Chem. Soc.*, 1940, 17, 281.
- 3 Siddiqui and Ahmad, *J. Ind. Chem. Soc.*, 1941, 18, 589.

TAMARIND-SEED PECTIN

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IN a previous publication¹ it was reported that, when an aqueous extract of the tamarind-seed kernel is treated with twice its volume of alcohol, a voluminous fibrous precipitate is obtained. In aqueous solution this substance sets to a firm jelly when treated with sugar and acid, and on account of this characteristic property it was regarded as a pectin. In view of the plentiful availability of tamarind seeds, attention was directed mainly at finding commercial uses for the pectin obtained from them. These attempts have resulted in its use as a sizing material for cotton and jute yarn, as a creaming agent for rubber latex and as a substitute for gums of the tragacanth type.

The material, as previously obtained¹, usually contained 14 per cent. of proteinous matter, 3 per cent. of reducing and non-reducing sugars and 5 per cent. of fibrous matter. The removal of these associated substances by repeated precipitation of the pectin from dilute aqueous solution by means of alcohol was tedious and difficult. It has now been found that, if instead of using the seed flour as the starting material, pounded seeds (size of a sweet pea) are taken for extraction, most of the proteins and fibres remain with the swollen seeds, and the pectinous matter passes into solution. After centrifuging and subsequent treatment with alcohol, the solution yields pectin containing 1.5 per cent. protein and 1 per cent. fibre. Further purification is achieved by repeating the process once or twice.

It was realized from the very beginning that the tamarind-seed pectin differs from the common fruit pectins in certain respects, for example, in the ability of its aqueous solution to set to a thick gel on the addition of borax¹. Its further divergences from fruit pectins have recently been pointed out by Nanji *et al.*², by Damodaran and Rangachari³ and by Ghose and Krishna⁴. Nanji *et al.* have reported that the tamarind-seed pectin is free from methyl ester groups and reducing sugars, that it does not form the calcium salt according to the Carre and Haynes reaction⁵, and that it does not yield any galacturonic acid on hydrolysis. On the other hand, Damodaran and Ranga-

chari report that it contains methoxyl grouping to the extent of 1.08 per cent. and uronic acid residues up to 12.59 per cent., and that among the products of hydrolysis the only sugars identified are *l*-arabinose and *d*-glucose. A re-examination of the material has shown that the results of Damodaran and Rangachari cannot be repeated⁴. At this stage it can, however, be stated that tamarind-seed pectin, unlike the fruit pectins, is not a derivative of galacturonic acid.

The tamarind-seed pectin in pure state is a colourless amorphous powder. Its aqueous solution is dextrorotatory ($[\alpha]_D^{20} = +71^\circ$) and does not reduce Fehling's solution. In the presence of sugar and weak acids, aqueous solutions of the pectin form well-set jellies; they also set to a thick gel on the addition of borax. In its colour reaction with iodine this pectin differs from fruit pectins considerably. In 0.5 per cent. solution a bright-yellow colour is formed, when only a few drops of iodine are added, but with excess of the reagent a greenish blue is produced. The latter colour changes to yellow, almost at once, if diluted with water. With a more concentrated solution of the pectin, a greenish-blue gel appears, which changes to an orange solution on addition of water. With tannic acid, a flocculent precipitate is readily formed from an aqueous solution of the pectin and from this precipitate the original pectin can be regenerated on treatment with alkali.

Though it does not respond to the Carre and Haynes reaction⁵, tamarind-seed pectin yields metallic compounds with cupric ammonium sulphate, Fehling's solution, strontium hydroxide, barium hydroxide, calcium hydroxide and potassium plumbate, and they separate as gelatinous precipitates. From these compounds the pectin can be recovered on treatment with mineral acids.

When tamarind-seed pectin is boiled under reflux with 5 per cent. sulphuric acid for 4 to 5 hours, it undergoes complete hydrolysis, and the reducing sugar, expressed as glucose, is 106.8 per cent. and not 83 per cent. as reported by Damodaran and Rangachari (*loc. cit.*). In the hydrolysate, xylose, galactose and glucose have been identified. The

pentose amounts to 30.5 per cent. when estimated according to the method of Kröber as modified by Angell, Norris and Resch⁶. The pectin undergoes oxidation, with moderately concentrated nitric acid, to produce primarily mucic and saccharic acids. Along with these some oxalic acid also is formed in varying yields. On account of the formation of oxalic acid, the quantitative estimation of mucic and saccharic acids could not be properly carried out.

The results so far obtained indicate that the constituting sugars of tamarind-seed pectin are xylose, glucose and galactose, and the specific optical rotation of the hydrolysate indicates that they are present in molecular amounts. The specific rotation $[\alpha]_D^{20}$ is found to be between 52° and 54° . A mixture of xylose, glucose and galactose, in molecular proportions, should have a specific rotation of 51.5° . Therefore, the pectin appears to be essentially a polysaccharide. It should, however, be noted that even the purest sample, as obtained by the liberation from metallic compounds and subsequent purification through repeated precipitations from dilute aqueous solutions by means of alcohol, contains a little nitrogen (0.2 per cent.) and phosphorus (0.04 per cent.), and it is difficult to say, at this stage, whether these elements arise from the pectin or from any associated impurity.

It may be pointed out in this connection that there are not many examples known of polysaccharides which have the property of setting to a jelly in the presence of sugar and acid. One such substance occurs in coffee seeds⁷. On hydrolysis the coffee seed pectin yields galactose and a pentose, while on oxidation it produces mucic acid. It is, however, not known whether this pectin also, like the tamarind-seed pectin, sets to a jelly with borax.

It is, therefore, clear that even though the tamarind-seed pectin has a different chemical constitution, it resembles the common fruit pectins in forming a gel with sugar and acid. In chemical constitution it bears some similarity to geloses, though it does not possess their characteristic property of setting to a gel without the aid of sugar and acid. Geloses, on the other hand, do not set to a jelly with sugar and acid. In forming a thick gel with borax in aqueous solutions, it exhibits a feeble resemblance to some gums and mucilages whose solutions are said to thicken when treated with borax. The

TABLE I

	Tamarind-seed pectin	Coffee-seed pectin	Fruit pectin	Agar-agar	Gum tragacanth	Gum arabic	Mucilage of the seeds of <i>Plantago ovata</i>
Alcohol	White flocculent precipitate	White precipitate	White flocculent precipitate	White precipitate	White precipitate with strong alcohol	White precipitate with strong alcohol	White precipitate with strong alcohol
Basic lead acetate	White gelatinous precipitate	White gelatinous precipitate	White gelatinous precipitate	White gelatinous precipitate	White precipitate with strong alcohol	White precipitate with strong alcohol	White precipitate with strong alcohol
Fehling's solution	Blue gelatinous precipitate	Incomplete precipitation	Blue gelatinous precipitate with large excess	No action	Opaque white solid	White gelatinous precipitate	No precipitate
Cupric ammonium sulphate	Blue gelatinous precipitate	Bluish-green precipitate	Do.	Bluish-green gelatinous precipitate	No precipitate	No precipitate	Do.
Tannin solution	Buff-coloured gelatinous precipitate	Precipitate obtained	No action	Thick opalescence which disappears on adding alcohol	Blue clots	Blue gelatinous precipitate	Do.
Iodine solution	Blue gel in strong solutions; pale yellow on dilution	No action	Do.	Bluish violet*	No action	No action	No action
Nitric acid	Mucic and saccharic acids	Mucic acid	Mucic acid	Mucic acid	Mucic acid mainly	Mucic acid mainly	Mucic acid mainly
Sulphuric acid (dilute)	Xylose, glucose and galactose	Pentose and galactose	Galacturonic acid chiefly	Galactose chiefly	Reducing sugars and a little galacturonic acid	Reducing sugars and a little galacturonic acid	Reducing sugars and a little galacturonic acid
Sugar and citric acid	A firm jelly	.....	A firm jelly	No action	No action	No action	No action
Borax	A thick jelly	.....	No action	Do.	Do.	Thickens	Do.

*Depends on concentration, temperature, etc.

relevant points of comparison and contrast between these various types of compounds are shown in Table I.

Experiments on acetylation and methylation of the pectin, its hydrolysis with oxalic acid and its oxidation with potassium permanganate and hydrogen peroxide have been carried out, and the results will be published in a subsequent communication.

Experimental

Preparation of Tamarind-seed Pectin.—The tamarind seeds were parched on hot sand at 125–150°C., and gently pounded, whereby the brittle *testa* came off easily from the kernels. After removing the *testa* by winnowing, the seeds were thoroughly washed in water and soaked further for 10 hours in half per cent. solution of sulphur dioxide in order to remove the still adhering colouring matter and tannin. After washing again in flowing water, they were dried in the sun and carefully pounded to the size of a sweet pea. After sieving off the finer particles, the coarse ones were taken for extraction. The material (100 gm.) was boiled with water (2 l.) for about half an hour and filtered through muslin. The residue was boiled twice again with water, each time taking one litre for the extraction. The total extract (4 l.), a whitish thin liquid, was cooled to room temperature and, after passing sulphur dioxide so as to form 0.5 per cent. solution, was allowed to stand for 8 to 10 hours to settle down the suspended and fibrous matter. The decanted solution was then centrifuged to remove further quantity of undissolved matter. The translucent fluid was now concentrated to nearly half its bulk on a water-bath, preferably under vacuum. From the concentrate, pectin was precipitated by the addition of three litres of 90 per cent. alcohol. For further purification, the fibrous mass was once again dissolved in water to make 1 per cent. solution, and reprecipitated with alcohol after removing the fibres by centrifuging. It was filtered and then ground with a small quantity of 90 per cent. alcohol and gently warmed when the gelatinous lumps broke up into crisp powder, filtered and dried first in an oven at 50° to 60° C. and then in a desiccator. The material thus obtained was colourless and shining and the yield was 50 gm. The air-dried sample contained 15.3 per cent. moisture; 0.5 per cent. nitrogen; 0.11 per cent. phosphorus; 1.0 per cent. fibrous matter and a small amount of oil.

The material readily dissolved in water giving a slightly translucent solution (1 per cent.) and it became more transparent when filtered through a filter-paper; but the filtration was extremely slow. The clear filtrate was dextrorotatory, having a specific rotation of $[\alpha]_D^{20} = 71.4^\circ$ when taken in 0.25 per cent. solution and was non-reducing towards Fehling's solution. The aqueous solution was slightly acidic, 500 c.c. of 0.1 per cent. solution requiring 0.2 c.c. of N/10 potassium hydroxide for neutralization.

Jelly formation.—1.5 gm. of the pectin was dissolved in 100 c.c. of water and to the boiling solution were added 65 gm. of sugar and 1 gm. of citric acid. The mixture was boiled for about 15 minutes, till its volume was reduced to 100 c.c., assuming a light syrupy consistency. On cooling it set to a thick jelly.

A 2 per cent. solution of the pectin was prepared and to it a small quantity of borax (7.5 per cent. on the weight of the pectin), in saturated solution, was added and stirred well, when it was converted into a semi-solid gel. Larger or smaller amounts of borax produced weaker gels. On warming, the gel became thin but set again on cooling. Either the thick gel or its thinner solutions, when dried on hot rollers or through hot air-tower by spray, became hard. This material, on crushing, looked and behaved very much like powdered gum tragacanth, and could be used as a substitute for it.

Reaction with Iodine.—Half per cent. solution of the pectin was taken and treated with iodine (N/10 in potassium iodide) in drops. The iodine colour was immediately discharged to yield a greenish-yellow colour, at the place of contact. This colour changed to yellow on shaking. On further addition of the iodine solution, the following sequence of colour changes was noticed: orange, dirty brown, greenish brown and finally greenish blue. On dilution with water, the colour changed to yellow. When a concentrated solution of the pectin (1 per cent. or over) was treated with iodine, a greenish-blue gel appeared at the final stage, and the gel too dissolved on the addition of water to produce an orange-yellow solution.

Interaction with Tannic Acid.—When a dilute solution of the pectin was treated with tannic acid (5 per cent. solution) in small amounts, a brownish flocculent precipitate appeared. After the precipitation was complete, the supernatant liquid was decanted

off and the solid was washed several times with water till it was free from tannic acid. On treatment with warm alcohol, it became crisp and fibrous. The yield was 1.5 gm. from 1 gm. of the pectin.

The pectin-tannate was more easily soluble in hot water than the pectin itself. It formed a well-set jelly with sugar even without the aid of citric acid, but the jelly was slightly astringent in taste. When a solution of the pectin-tannate was boiled with alkali and subsequently treated with three times its volume of alcohol, pectin precipitated out.

Preparation of Metallic Compounds*

(a) *Copper-pectins*.—(i) The pectin (1 gm.) was dissolved in cold water (200 c.c.) and the dissolution completed by boiling. The translucent solution so obtained was treated in the cold with Fehling's solution, in drops, with vigorous stirring. When the mixture had assumed a dull-green colour, copper pectin began to separate as a gel. More Fehling's solution was added till the reaction mixture was definitely blue. When the stirring was stopped, the product settled down. The supernatant liquid was carefully decanted off, and the solid was filtered through fine silk and washed thoroughly with cold water till it was free from the reagent and the unreacted pectin. The gelatinous mass was then washed successively with 30 and 60 per cent. alcohol (at 50° to 60° C.) and finally with pure warm alcohol, when it became quite crisp. After draining off the wash liquor by squeezing, the solid was dried in an oven at 50 to 60° C. for 24 hours and later in a vacuum desiccator. The dry material contained 6.4 per cent. copper.

(ii) The cupric compound was also prepared by the treatment of the pectin with cupric ammonium sulphate instead of Fehling's solution, care being taken to avoid free ammonia. The procedure for precipitation of the compound was the same as that described in the previous case. It contained 6.8 per cent. copper.

(b) *Lead-pectin*.—This was obtained by the gradual addition of a saturated solution (200 c.c.) of potassium plumbate to a 0.5 per cent. solution of the pectin (400 c.c.).

* The purification of these compounds is a matter of considerable difficulty as they have a tendency to absorb some of the unreacted pectin and undergo decomposition even in boiling water, which cannot, therefore, be used for this purpose. Consequently the analytical data presented in this section are only approximate.

The procedure was the same as in the case of copper compounds. The precipitate did not appear in any quantity till about 150 c.c. of the reagent had been added and the reaction was brought to completion by the addition of a further 50 c.c. of the reagent. The precipitate formed was granular and pinkish in colour. The purification and drying of the compound were effected as in the previous case. The dry product contained 21.5 per cent. lead.

(c) *Barium-pectin*.—This reaction should be carried out in a closed flask and as quickly as possible; otherwise the final product is likely to get contaminated with barium carbonate. The experiment was carried out with different concentrations of the pectin in order to eliminate the possibility of any of the barium hydroxide being adsorbed by the product, at higher concentrations. The pectin (1.5 gm.) was dissolved in water (100 c.c.) by heating if necessary, so that the material was in a fully swollen condition. It was then treated with a saturated solution of barium hydroxide in small amounts, and the mixture was shaken well after every addition. The solution became thinner and thinner as the addition progressed. When about 125 c.c. of barium hydroxide had been added, the barium compound began to separate out and the reaction was brought to completion by further addition of 25 c.c. of the reagent, in two instalments, with vigorous shaking. The precipitate, as it formed, appeared to be granular but on settling became a soft elastic clotty mass. When the deposition was complete (10 minutes), the supernatant liquid was decanted off, and the precipitate washed first with a small amount of cold water and then successively with 60 and 90 per cent. warm alcohol (50° to 60° C.) when the clotty mass changed into a crisp powder. Much water should not be used in the initial washing, as the substance showed a tendency to dissolve in water to some extent. After filtration through silk, the material was dried as in the previous case. It contained 6.9 per cent. barium. The barium contents of the products obtained, starting with 1.0 and 0.75 per cent. pectin solution, were 12.5 and 10.5 per cent., respectively.

(d) *Strontium-pectin*.—The procedure was identical to that adopted in the case of barium compounds. 200 c.c. of a saturated solution of strontium hydroxide were required to precipitate the compound from

100 c.c. of a 1 per cent. solution of the pectin. In this case, the product was less elastic and more granular than the barium compound and the purification was effected similarly. It contained 8.9 per cent. strontium.

(e) *Calcium compound*.—On account of the low solubility of calcium hydroxide, a very large excess of this reagent had to be added even to a 2 per cent. solution of the pectin, before the product separated out. In its structure and properties it resembled the barium and the strontium compounds.

Liberation of Pectin from the Metallic Compounds.—One gram of copper-pectin was finely powdered and suspended in 100 c.c. of warm water. The mixture was thoroughly agitated till a uniform suspension was obtained. It was then treated, while still hot, with a slight excess of hydrochloric acid, heated on the water-bath for about 10 minutes, cooled and filtered through silk. The filtrate on treatment with three times its volume of 90 per cent. alcohol precipitated the pectin in the form of a gel. The latter was filtered through silk, washed with a small amount of cold water, then with 60 per cent. alcohol and finally with 90 per cent. alcohol. On maceration with hot alcohol, the gel broke up into granular powder which was subsequently filtered and dried at 50° to 60° C. The recovery was 0.75 gm. This sample retained in full the jelly-forming property of the original pectin. The material recovered was, however, purer than the starting material (pectin) as was indicated by the reduction in its nitrogen (0.2 per cent.) and phosphorus (0.04 per cent.) contents.

Hydrolysis with 5 per cent. Sulphuric Acid.—1 gm. of the pure air-dried pectin was boiled under reflux with 50 c.c. of 5 per cent. sulphuric acid for 4 hours. The temperature was gradually raised to the boiling point to avoid charring. At the end of the hydrolysis almost the whole of the substance was in solution except a small amount, possibly some fibrous matter. After cooling, the contents were filtered through a tared filter paper and the fibrous residue estimated by weighing (1 per cent.). The reducing sugars in the filtrate were estimated according to the method of Allihn, calculated as glucose, and they totalled to 106.8 per cent. on the basis of pure anhydrous material. The specific rotation of the hydrolysate was $[\alpha]_D^{20} = 52$ to 54°.

Identification of Sugars in the Hydrolysate.—The sugars were identified as osazones. On adding phenyl hydrazine hydrochloride and sodium acetate to the hydrolysate after neutralization and heating on the water bath, a mixture of osazones separated out. The first fraction which appeared within ten minutes was identified as xylosazone (m.p. 160° C.). The osazone obtained after thirty minutes' heating was almost pure glucosazone (m.p. 210°—212° C.). The last fraction which separated out on cooling the clear mother-liquor (after 1 hour's heating) was galactosazone (m.p. 195°—96° C.). Only these three sugars, namely, xylose, glucose and galactose, could be identified. The presence of xylose was confirmed by the preparation of cadmium bromide-cadmium xylonate.

Estimation of Xylose.—One gram of the pure pectin was treated with 100 c.c. of 12 per cent. hydrochloric acid (*d.* 1.06) and distilled over a glycerol-bath (175°—80° C.) 12 per cent. hydrochloric acid was gradually added to the distillation flask, so that the rates of addition and distillation were almost equal. After 2 hours, the distillate which should be about 360 c.c. was filtered and treated with 0.5 gm. of phloroglucinol dissolved in hydrochloric acid. The precipitate was allowed to stand overnight, filtered and weighed.

Calculated on the basis of dry material the pectin contained 30.5 per cent. of xylosan.

Oxidation with Nitric Acid.—The substance (2 gm.) was treated with nitric acid (20 c.c. *d.* 1.15), in a conical flask and heated on a water-bath. A small quantity of fibrous mass separated out, and it was removed by filtration. The filtrate was concentrated (8 c.c.) in a basin over a water-bath and extracted with ether. A small quantity of oxalic acid was recovered from the ether extract. The aqueous solution was left overnight, when mucic acid (m.p. 225°—27°) separated out as colourless crystals. The mother-liquor, on concentration, yielded a further quantity of mucic acid. Finally, the solution was concentrated to a syrupy consistency, and treated with potassium carbonate till it was alkaline to litmus. It was then acidified with acetic acid and left overnight, when potassium hydrogen saccharate separated out as a crystalline mass. It was further identified by conversion into diphenyl hydrazide (m.p. 210° C.).

Summary

The tamarind-seed pectin, unlike the fruit pectins, is essentially a polysaccharide, producing xylose, glucose and galactose on complete hydrolysis with dilute sulphuric acid. On oxidation with nitric acid it yields mucic and saccharic acids.

Even the purest sample of the pectin so far obtained contains a small amount of nitrogen and phosphorus, and it is not known whether these elements arise from the pectin itself or from any associated impurity still present.

References

- 1 Ghose, T. P., and Krishna, S., *J. Indian Chem. Soc., Ind. & News Ed.*, 1942, **5**, 114.
- 2 Nanji, H. R., Savur, G. R. and Sreenivasan, A., *Curr. Sci.*, 1945, **14**, 129.
- 3 Damodaran, M., and Rangachari, P. N., *Curr. Sci.*, 1945, **14**, 203.
- 4 Ghose, T. P., and Krishna, S., *Curr. Sci.*, 1945, **14**, 299.
- 5 Carre, M. H., and Haynes, D., *Biochem. J.*, 1922, **16**, 60.
- 6 Angell, S., Norris, F. W., and Resch, C. E., *Biochem. J.*, 1936, **30**, 2146.
- 7 Gorter, K., *Ann.*, 1908, **359**, 217.

RELATIVE DIGESTIBILITY OF COMMON EDIBLE FATS

PART I—BY RICINUS LIPASE

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THE production and use of hydrogenated oils in this country as human food have steadily increased in spite of the initial prejudice against them. Hydrogenated oils have been employed for the adulteration of ghee, and the scarcity of ghee and its high price during the war have led to a great increase in their consumption. Hydrogenated oils possess certain distinct advantages. Thus they are standardized products prepared from deodorized and refined vegetable oils under hygienic conditions. They have good keeping qualities and the appearance, texture and flavour of ghee.

The investigation of the nutritive value of fats presents many aspects. While some work has been done in this country and abroad on the relative digestibilities of a number of oils and animal fats, there have been practically no studies on hydrogenated oils. In this investigation, the digestibilities of common edible fats including hydrogenated oils have been studied *in vitro* by using ricinus lipase.

Work on the subject include those of Langworthy and Holmes¹, Gardner and Fox², Langworthy³, Barbour⁴, and Longnecker and Haley⁵ who studied the relative digestibilities of fats by animal feeding experiments. Keltaro Erzo⁶, Gladys and Hartwell⁷, and Dastur and Giri⁸ studied the relative digestibilities of certain edible fats *in vitro*, using pancreatic lipase. There is no reported data on the relative digestibilities of hydrogenated vegetable oils.

Experimental

The enzyme preparation used in this investigation was obtained by employing a slightly modified method of Longnecker and Haley⁵. Fresh castor beans were hulled and extracted by dry petroleum ether (B.P. 20°-40° C.) in a Soxhlet for 24 hours (with repeated pulverization). The product was dried under vacuum and sifted through fine muslin. The powder retained its lipase activity for long intervals when stored under vacuum at 0° C.

The digestibility of fats was followed by the following procedure: 1 gm. of the fat was weighed out into glass-stoppered Jena glass bottles (50 cc.) to which was added 0.1 gm. of the enzyme powder. The digestion was started by the addition of 1 cc. of an acetate buffer (pH. 4.2) and the mixture shaken for three minutes in order to ensure complete emulsification. It was then incubated at 37° C. The bottles were withdrawn at the required intervals of time, digestion arrested by pouring 25 cc. of boiling water, a mixture of alcohol (20 cc.) and ether (20 cc.) added to dissolve the fatty acids, and the acids estimated by titration against 0.1 N KOH with phenolphthalein (0.2 per cent., 10 drops) as indicator. Suitable controls containing no enzyme were run side by side.

The rates of hydrolysis of the following oils and fats were studied:

- (a) Natural ghee,
- (b) Vegetable oils (12),

TABLE I. *Hydrolysis of Ghee (buffalo)*

Ghee No.	cc. of 0.1 N KOH required					
	10 min.	20 min.	30 min.	40 min.	60 min.	120 min.
20	5.95	9.65	12.70	14.05	15.85	20.45
18	6.45	10.65	14.45	16.20	17.95	23.05
2	6.50	10.50	13.40	15.95	18.60	22.80
30	6.70	10.20	13.40	15.45	17.85	22.85
35	6.20	9.90	13.15	14.60	16.10	21.25

TABLE II. *Hydrolysis of Vegetable Oils by Ricinus Lipase*

Oils	cc. of 0.1 N KOH required					
	10 min.	20 min.	30 min.	40 min.	60 min.	120 min.
Mahua (<i>Basia latifolia</i>)	14.95	20.50	22.85	25.90	27.70	32.20
Kadoo (<i>Cucurbita maxima</i>)	10.80	18.10	21.30	24.40	27.40	30.20
Coconut (<i>Cocos nucifera</i>)	11.40	17.75	20.95	24.30	27.10	29.80
Linseed	9.95	15.35	17.00	20.40	25.60	28.40
Sesame (<i>Sesamum indicum</i>)	9.10	14.50	17.85	20.50	25.80	28.50
Almond (<i>Anacardium occidentale</i>)	7.10	12.00	14.45	17.65	22.00	28.00
Cottonseed (<i>Gossypium sp.</i>)	6.05	10.20	13.70	16.10	18.60	25.30
Groundnut (<i>Arachis hypogea</i>)	6.80	9.70	12.95	16.20	18.80	22.70
Mustard (<i>Brassica juncea</i>)	6.85	9.05	11.80	14.60	18.50	21.80
Taramira (<i>Brassica eruca</i>)	5.80	8.90	10.25	13.35	16.20	21.50
Castor (<i>Ricinus communis</i>)	5.65	9.75	11.60	14.35	18.20	21.00
Olive (<i>Olea europaea</i>)	4.45	7.20	8.90	10.30	14.10	15.70

TABLE III. *Hydrolysis of Hydrogenated Vegetable Oils*

Brand	M.P. °C.	cc. of 0.1 N KOH required					
		10 min.	20 min.	30 min.	40 min.	60 min.	120 min.
1	38	5.50	8.15	12.00	14.80	19.80	22.60
2	37	5.90	8.55	11.25	13.65	17.45	21.85
3	30-32	4.90	6.90	11.45	13.85	18.00	21.70
4	38-40	6.05	8.65	10.80	12.50	16.00	20.50
5	38	5.05	6.25	10.50	12.50	16.30	20.10
6	33-34	5.40	8.40	11.45	13.65	16.00	19.67
7	..	4.85	7.90	10.75	12.20	14.85	17.75
8	42	4.75	7.60	8.85	10.00	11.90	16.40
9	35	3.85	5.37	9.50	10.10	13.80	15.95
10	36	5.10	7.50	8.90	9.72	12.40	15.40
11	40	6.65	10.20	11.70	11.95	12.30	14.80
12	39	4.00	8.10	8.95	9.20	10.10	12.50

TABLE IV. *Digestibility of Animal Fats*

Substance	M. P. °C.	cc. of 0.1 N KOH required					
		10 min.	20 min.	30 min.	40 min.	60 min.	120 min.
Pig's lard	42	4.00	8.00	10.75	14.50	17.90	21.90
Beef tallow	47	2.40	3.70	4.90	5.50	8.85	14.70
Sheep tallow	51	2.35	3.90	5.10	6.75	8.40	13.00
Goat tallow	53	2.30	3.30	4.20	5.30	7.20	11.30
Cod liver oil	..	2.80	3.30	3.45	3.50	4.80	4.90

TABLE V. *Digestibilities of some Common Edible Fats of Vegetable and Animal Origin*

Edible fat	cc. of 0.1 N KOH required					
	10 min.	20 min.	30 min.	40 min.	60 min.	120 min.
Coconut oil	17.50	23.50	26.50	29.00	30.50	33.20
Sesame oil	15.00	19.40	23.65	25.70	27.90	30.60
Buffalo ghee	12.00	16.90	20.80	24.00	28.00	30.50
(Vanaspati) Brand No. 2	6.60	10.90	13.95	15.00	18.50	21.80
Lard	4.00	8.00	10.75	14.50	17.90	21.90
(Vanaspati) Brand No. 5	4.80	8.00	10.70	13.10	15.90	16.90

- (c) Hydrogenated oils (12), and
(d) Body fats of animals (4).

(a) *Natural Ghee*.—Five different samples of buffalo ghee were studied. The samples were obtained through the courtesy of the Public Health Chemist, Government of Punjab, from different localities in the Province and prepared under his supervision from genuine unadulterated milk by the common country method. The results of hydrolysis by lipase are summarized in Table I.

It is often stated that ghees obtained from different localities have different characteristics. The results obtained in our study do not show any significant differences in the rates of hydrolysis of the different samples collected from different localities.

(b) *Vegetable Oils*.—Twelve different edible oils were investigated. The samples were obtained from the market. The results of hydrolysis by lipase are summarized in Table II.

The data reveal marked differences in the rate of digestibility of different vegetable oils. They can be arranged as follows in the decreasing order of digestibility: *Mahua*, *kadool*, coconut, linseed, sesame, almond, cottonseed, groundnut, mustard, *taramira*, castor and olive.

(c) *Hydrogenated Vegetable Oils (Vanaspathi)*.—Twelve samples of different brands of the hydrogenated oils have been studied. The results of digestibility are shown in Table III.

An examination of the above data reveals considerable differences in the rates of digestibility of different brands of hydrogenated products. They can be arranged as follows in the decreasing order of digestibility: Brand No. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12.

The melting point of the hydrogenated oil is considered to be an important factor in digestibility. The figures given in Table III show that the rates of digestibility do not vary strictly with the melting point. Other factors are evidently involved.

(d) *Animal Fats*.—Four body-fats of animals, viz., pig, beef, sheep and goat, were collected and studied. Since these fats have high melting points and are solid at the room temperature, they were melted and emulsified with the buffer before incubation with the enzyme. The results of digestion of the fats, and also of cod liver oil, are given in Table IV.

Pig lard is more readily hydrolysed than others. Beef, sheep and goat tallow follow in the decreasing order of digestibility.

(e) *Relative Digestibilities of Different Edible Fats*.—Six samples were selected out of the four groups (a—d) and their relative digestibilities determined. The results are shown in Table V and Fig. 1.

The experiments show that coconut oil is hydrolysed most readily and to the greatest extent. This oil and sesame oil are hydrolysed

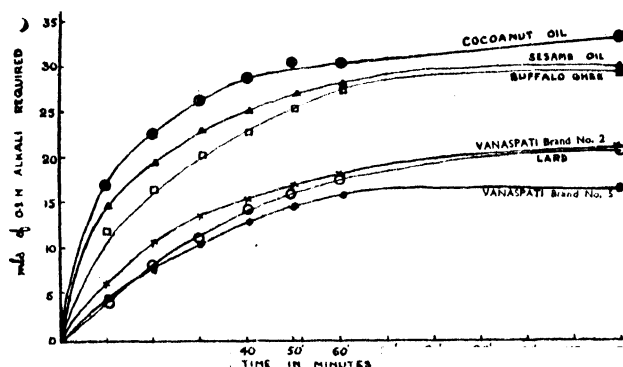


Fig. 1. Relative digestibility of different fats.

more readily than ghee. Lard and vegetable ghee follow next and both are digested more or less at the same rate.

Summary

The rates of digestibility by ricinus lipase of 5 samples of buffalo ghee, 12 vegetable oils, 12 brands of hydrogenated oils, 4 body-fats from animals, and cod liver oil have been investigated.

Coconut and sesame oils are readily digested by ricinus lipase. Mustard oil has a lower digestibility and is comparable in this respect to buffalo ghee, lard and one or two better brands of hydrogenated oils. Olive oil showed exceedingly poor digestibility and was comparable to beef tallow and the majority of the hydrogenated oils.

References

- Langworthy, C. F., and Holmes, A. D., *Bull. U.S., Dep. Agr.*, No. 310, 1915; Nos. 505 and 507, 1917.
- Gardner and Fox, *Biochem. J.*, 1919, 13, 268.
- Langworthy, C. F., *Analyst*, 1923, 48, 232.
- Barbour, A. D., *J. Biol. Chem.*, 1934, 106, 281.
- Longnecker, H. E., and Haley, D. E., *J. Amer. Chem. Soc.*, 1935, 57, 2019.
- Erzo Keltaro, *J. Expt. Digest. Dis. Jap.*, 1929, 28, 190.
- Gladys and Hartwell, G. A., *Biochem. J.*, 1926, 32, 462.
- Dastur, N. N. and Giri, K. V., *Ind. Jour. Med. Res.*, 1937-38, 25, 427.

THE DIELECTRIC PROPERTIES OF MANILA COPAL

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Introduction

THE dielectric properties of a few natural resins have recently been studied^{1,2}. The results of this study coupled with their viscosity data at different temperatures have revealed the dimensions of their rotators in the alternating electric field. Thus it has been observed that the large and complex molecules of resins do not rotate as a whole in the alternating field but only certain polar groups are responsible for this rotation accounting for their dielectric loss. In this way hydroxyl groups have been found to be the main rotators in lac¹, whilst mastic and dammar rotating units² are comparatively bigger in size.

Copal resins are important from the standpoint of the electrical industry as they are widely used in the preparation of insulating varnishes, impregnating compounds, moulded insulation, etc. These resins comprise various fossil and semi-fossil resins usually found in tropical countries. The commercial resin is generally graded according to its hardness, country of origin and colour. But the varieties of resins which go by the name of copal sometimes differ so much in their physical and chemical properties that it is extremely doubtful if it is advisable to take any one of them as a representative sample, even when their locality of origin as well as commercial grade are the same. In the circumstances, although the object of this investigation was primarily to find out the general dielectric behaviour of copal, the extent of its application may be strictly limited.

Now lac is also extensively used for the purpose of electrical insulation and these two resins, lac and copal, mostly serve the requirements of the electrical industry even in these days of synthetics. It is of interest, therefore, to compare the dielectric properties of copal with those of lac.

Theoretical

We know^{1,2} that the dielectric properties of a substance may be expressed as

$$\epsilon = \epsilon' - i\epsilon''$$

where ϵ = the complex dielectric constant,

ϵ' = the ordinary dielectric constant,

and ϵ'' = the dielectric loss factor;

Also $\epsilon'' = \epsilon' \tan \delta$, where δ = loss angle.

Now the current in phase with the voltage in a condenser having dielectric loss is $I_r = I \tan \delta = \omega CV \tan \delta$

$$= 2\pi f CV \epsilon'' / \epsilon'$$

But the value of C for a parallel plate condenser of area A and dielectric thickness d is given by

$$C = \frac{A \epsilon'}{4\pi d \times 9 \times 10^{11}} \text{ farads.}$$

Therefore, substituting this value of C , we have

$$I_r = \frac{fAV\epsilon''}{18 \times 10^{11} \times d}$$

Again, if K_t is the total conductance of this condenser

$$I_r = AVK_t$$

$$\text{Therefore, } \epsilon'' = \frac{18 \times 10^{11} \times K_t}{f}$$

But $K_t = K_o + K$, where K_o and K are the d.c. and a.c. conductance respectively.

$$\text{Hence pure a.c. loss } \epsilon'' = \frac{18 \times 10^{11} (K_t - K_o)}{f}$$

Experimental

Apparatus.—The bridges employed for capacity and power factor measurements were the same as previously reported^{1,2} for other resins. The oscillators, the amplifier and the detector were also the same. The cell used has also been described earlier¹.

Material.—The sample of copal used was a commercial grade resin marked "Manila Copal, hard" and was obtained from Napier Paint Works Ltd., Calcutta. This sample was first melted and filtered through two folds of muslin cloth to get rid of any foreign matter, if present. The softening and melting points of the sample determined by the mercury surface method³ were 93°-94° C. and 106°-107° C. respectively. The

resin was almost transparent, pale yellow in colour and had large irregular pieces which after melting and filtration gave a clear, pale brownish-yellow liquid. On cooling, however, the solidified resin retained this colour.

Method of Procedure.—The procedure followed for the measurement of capacity and power factor as well as for filling up the experimental cell has been described in some detail elsewhere^{1,2} and so is not repeated here.

Results

TABLE I. Dielectric constant—temperature data at different frequencies.

Temp. °C.	Dielectric constant ϵ' at the frequency of					
	500 Kc/s	100 Kc/s	50 Kc/s	10 Kc/s	1 Kc/s	50 C/s
30	2.61	2.63	2.64	2.66	2.67	2.70
40	2.62	2.64	2.65	2.66	2.67	2.72
50	2.65	2.67	2.68	2.69	2.71	2.75
60	2.69	2.72	2.73	2.74	2.78	2.80
70	2.72	2.76	2.78	2.82	2.91	2.94
80	2.76	2.80	2.83	2.90	3.09	3.25
90	2.81	2.91	2.96	3.09	3.43	3.83
100	2.89	3.02	3.11	3.34	3.82	4.25
110	2.98	3.18	3.32	3.68	4.04	4.33
120	3.09	3.39	3.53	3.85	4.06	4.30
130	3.26	3.60	3.74	3.98	4.06	4.22
140	3.46	3.80	3.88	4.00	4.04	4.12
150	3.58	3.83	3.89	3.95	3.98	4.02

TABLE II. Measured power factor data at various temperatures and frequencies.

Temp. °C.	Power factor at the frequency of					
	500 Kc/s	100 Kc/s	50 Kc/s	10 Kc/s	1 Kc/s	50 C/s
30	Very low	0.0042	0.0048	0.0050	0.0042	Very low
40	"	0.0040	0.0042	0.0042	0.0042	"
50	"	0.0044	0.0044	0.0042	0.0043	"
60	"	0.0064	0.0064	0.0065	0.0065	0.0090
70	0.0043	0.0087	0.0109	0.0133	0.0208	0.0250
80	0.0074	0.0141	0.0164	0.0237	0.0404	0.0550
90	0.0132	0.0256	0.0325	0.0446	0.0656	0.0701
100	0.0227	0.0408	0.0523	0.0629	0.0670	0.0400
110	0.0374	0.0599	0.0730	0.0693	0.0444	0.0181
120	0.0534	0.0745	0.0771	0.0544	0.0230	0.0080
130	0.0691	0.0712	0.0617	0.0375	0.0128	0.0060
140	0.0766	0.0536	0.0427	0.0212	0.0077	0.0340
150	0.0618	0.0373	0.0269	0.0097	0.0050	....

TABLE III. Corrected dielectric loss—temperature data at various frequencies.

Temp. °C.	Dielectric loss ϵ'' at the frequency of					
	500 Kc/s	100 Kc/s	50 Kc/s	10 Kc/s	1 Kc/s	50 C/s
30	....	0.0112	0.0126	0.0133	0.0112	....
40	....	0.0105	0.0110	0.0111	0.0112	....
50	....	0.0117	0.0118	0.0117	0.0118	....
60	....	0.0174	0.0176	0.0177	0.0182	0.0253
70	0.0116	0.0239	0.0303	0.0375	0.0605	0.0738
80	0.0203	0.0395	0.0465	0.0687	0.1249	0.1788
90	0.0372	0.0745	0.0963	0.1379	0.2282	0.2681
100	0.0656	0.1231	0.1626	0.2102	0.2562	0.1865
110	0.1115	0.1905	0.2423	0.2651	0.1794	0.0761
120	0.1649	0.2526	0.2724	0.2093	0.0927	0.0254
130	0.2269	0.2564	0.2307	0.1490	0.0508	....
140	0.2652	0.2036	0.1654	0.0850	0.0310	....
150	0.2214	0.1427	0.1043	0.0382	0.0200	....

TABLE IV. D.C. Conductance and resistivity data at various temperatures.

Temperature		1000	σ	ρ	$\log \rho$
°C	T°K	T			
90	363	2.755	Very low	Very high	....
95	368	2.717	4.00×10^{-15}	2.50×10^{14}	14.40
100	373	2.681	1.16×10^{-14}	8.62×10^{13}	13.94
105	378	2.646	3.49×10^{-14}	2.87×10^{13}	13.46
110	383	2.611	7.75×10^{-14}	1.29×10^{13}	13.11
120	393	2.545	2.86×10^{-13}	3.50×10^{12}	12.54
130	403	2.481	8.21×10^{-13}	1.22×10^{12}	12.09
140	413	2.421	2.02×10^{-12}	4.95×10^{11}	11.69
150	423	2.364	5.50×10^{-12}	1.82×10^{11}	11.26

TABLE V. Viscosity data at various temperatures.

Temperature		1000	Viscosity in poise η	$\log \eta$
$^{\circ}\text{C}$	$^{\circ}\text{K}$	T		
95	368	2.717	71	1.848
100	373	2.681	204	2.309
105	378	2.646	806	2.906
110	383	2.611	2040	3.310
120	393	2.545	4921	3.692
130	403	2.481	13550	4.132

TABLE VI. Relaxation time and radius of the rotator.

Frequency	Loss—maximum temperature t_m	Relaxation time τ	Viscosity η	Radius a
1 Kc/s	97° C.	1.14×10^{-4}	8510	3.78×10^{-8} cm
10 Kc/s	109° C.	1.14×10^{-5}	820	3.87×10^{-8} cm
50 Kc/s	121° C.	2.28×10^{-6}	196	3.68×10^{-8} cm
100 Kc/s	127° C.	1.14×10^{-6}	100	3.67×10^{-8} cm

Discussion

The power factor-temperature, the dielectric constant-temperature and the dielectric loss-temperature curves (Figs. 1 and 2) all indicate the characteristics of a typical polar liquid in the anomalous dispersion range as have been noticed in the case of other resins. The peak of the power factor curve at any frequency reaches a value of about 0.075 and the loss-peaks for practically all the frequencies show a value of about 0.275. In these respects, therefore, copal resin resembles dammar². The maxima of dielectric constant curves also indicate almost identical values. A comparison with similar lac curves¹ will at once show that they attain very much higher values at their peaks.

It may be noticed, however, that the power factor as well as the dielectric loss curves of this sample of copal begin to rise from about 50° C. Below this temperature, the power factor of the resin is very low. The dielectric constant variation and consequently the dielectric loss is also extremely small below 50° C. It is quite possible, therefore, that some change of state is taking place near about this temperature. It has not been possible to measure plasticity or even d.c. conductivity at such a low temperature and so this point could not be verified. But at a much higher temperature, viz., 105°–106° C. (the melting point of the resin) clear evidence of a "transformation point" has been

obtained both from viscosity as well as d.c. conductivity measurements. We shall revert to this subject later.

The low value of power factor and dielectric loss of Manila copal may strike one for an explanation, since according to Tschirch and Koch⁴ about 80 per cent. of the resin are acids and about 12 per cent. is a resene called mancopaloresene, $\text{C}_{20}\text{H}_{32}\text{O}$. The main acid is the mancopalolic acid, $\text{C}_{10}\text{H}_{18}\text{O}_2$, which constitutes about 75 to 80 per cent. of the resin according to samples, and sometimes two other acids, mancopalic acid, $\text{C}_8\text{H}_{12}\text{O}_2$, and mancopalenic acid, $\text{C}_8\text{H}_{14}\text{O}_2$, are obtained from soft, dull samples of this resin; but these latter acids do not constitute more than 4 per cent. only and they were found absent in hard, lustrous samples of Manila copal. If we only think of resin acids leaving aside resenes for the present, we shall find on a little calculation that the number of carboxyls per unit volume of hard Manila copal are as many as eight times those present in dammar. We notice, however, that the maximum dielectric constant is practically the same in both the resins. The conclusion is, therefore, that we cannot consider only the carboxyls in the calculation of electric moment of the rotator. The constitution of these resin acids is not known and there are also resenes besides these acids in the resins, naturally other polar groups will also contribute towards polarization. Very little is known about resenes at present and Barry⁵ has thus regretfully observed "Investigation on the nature and function of the resene, and particularly the relations obtaining between it and the acidic substance, is therefore a matter of first importance and at the present time it must be admitted that we know practically nothing about it." In a previous paper² the difference in the calculated value of radius of mastic and dammar rotating units from experimental data also shows that the carboxyls are not the only polar groups there, although an explanation for their dielectric behaviour could be given taking into account their carboxyls only.

The anomalous dispersion of Manila copal at various temperatures has been shown in Figs. 3 and 4. To see the effects of distribution in the relaxation time use was made of the relation

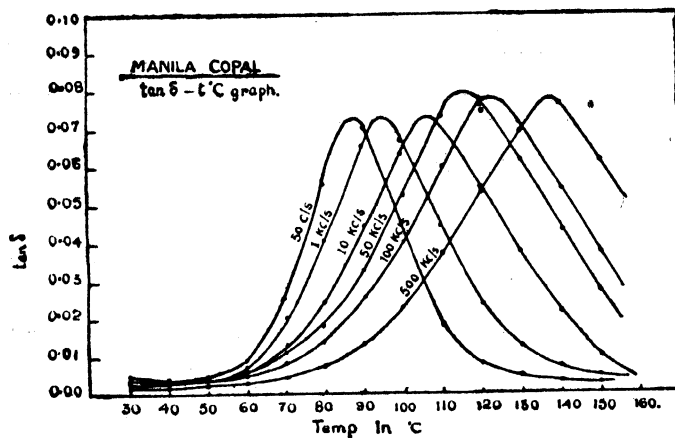


Fig. 1

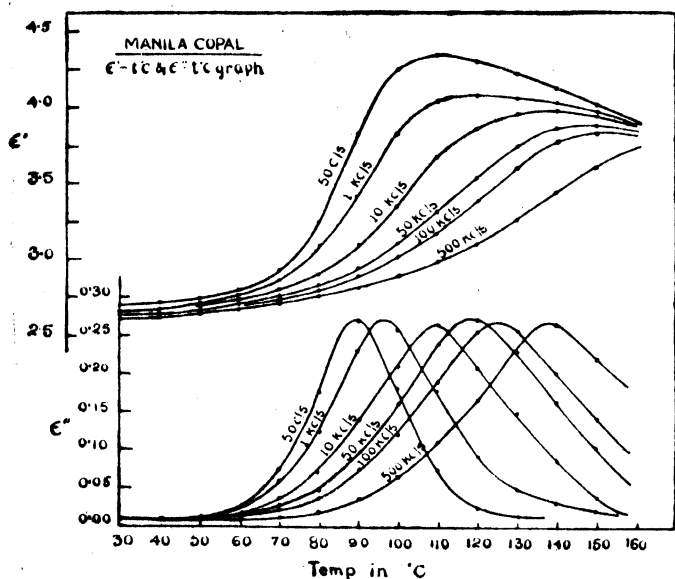


Fig. 2

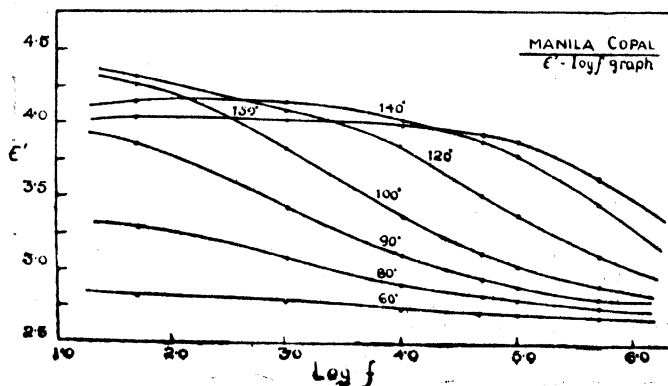


Fig. 3

where ϵ''_m = the maximum value of loss of a simple polar liquid,
 ϵ'_0 = the static dielectric constant of that liquid,
 and ϵ'_∞ = the value of dielectric constant at very high frequencies.

It is found that the actual loss-maximum of copal is only about one-third of the theoretical value calculated according to the above formula, thus indicating the effects of distribution in the relaxation time of the copal rotator. As shown previously¹ an idea of this distribution can be had by the plot of ϵ''/ϵ''_m against $\log f/f_m$. This has been shown in Fig. 5. For the sake of comparison of bluntness, two other curves, viz., of mastic and lac, have been included. It may be seen that the copal curve lies below mastic curve in this figure. Calculation according to Fuoss and Kirkwood⁶ gives a value of 0.48 for α , the distribution coefficient, thus showing a similarity in this respect between copal and mastic².

Now in order to calculate the radius of the rotating unit from the relation

$$\tau = \frac{4\pi\eta a^3}{kT}$$

where τ = relaxation time,
 η = coefficient of viscosity,
 a = radius of the rotator,
 k = Boltzmann constant,
 and T = absolute temperature,

the relaxation time τ and viscosity η should be known at any temperature T . Relaxation time τ may, however, be calculated from another relation

$$\omega\tau = \frac{\epsilon'_{\infty} + 2}{\epsilon' + 2}$$

at the temperature T corresponding to the peak of the dielectric-loss curve at a fixed frequency, but viscosity η at that temperature cannot be so calculated and, therefore, had to be determined by means of Lee's tar viscometers. The result of this viscosity determination has been shown in Table V and graphically in Fig. 6 along with d.c. conductivity and resistivity data. The d.c. conductivity of an insulating substance like resin is due to the mobility of its free ions and hence its variation with temperature gives an idea of the temperature dependence of its inner viscosity since mobility depends on viscosity. It may be seen that both the d.c. conductivity and the viscosity graphs show a "transformation point" of the resin near about its melting point. The molar activation energy Q calculated from the slope of the viscosity as well as resistivity graphs also gives more or less the same value, viz., 62 K-cal below melting point and 33 K-cal above it.

The calculation of the radius of the rotator, a , is now possible using η and τ corresponding to the loss-peak temperature T at any frequency. The average radius of Manila copal rotator is thus seen to be only 3.8 A.U. and it, therefore, stands midway between those of dammar and mastic in size. It must be clearly understood, however, that the application of Stoke's law presupposes the spherical shape of the rotators and there is no justification for this assumption except for rotators of very small size. But still for the sake of comparison we find that this unit is

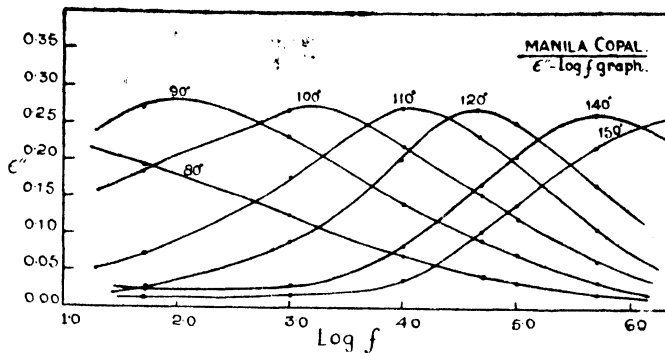


Fig. 4

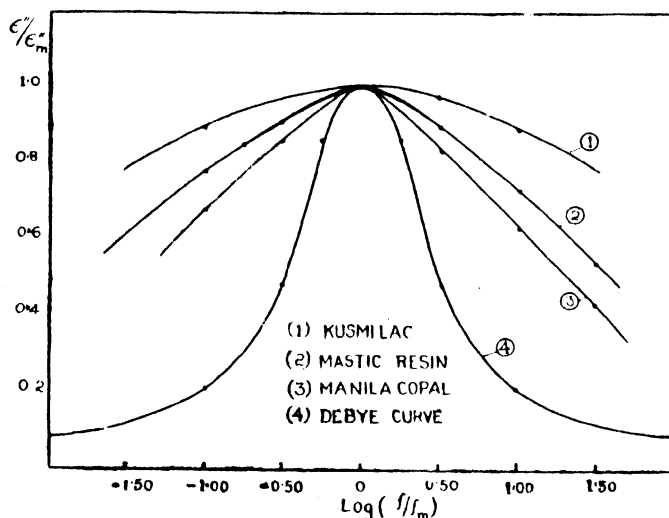


Fig. 5

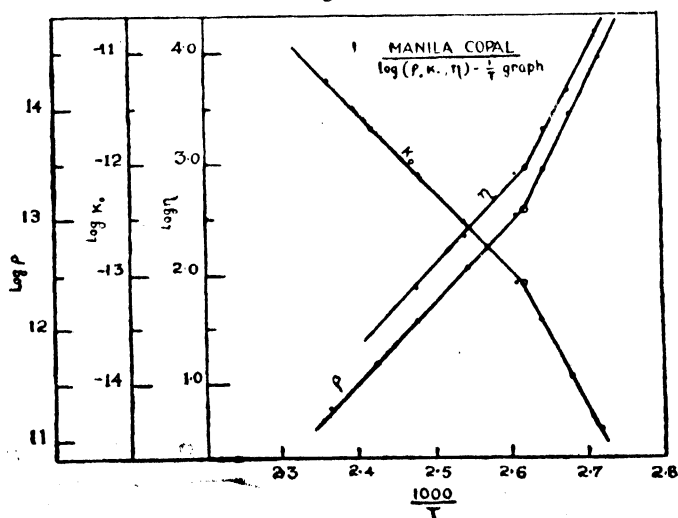


Fig. 6

much bigger than the lac rotator. However, our previous general conclusion² that the whole resin molecule does not rotate in the electric field but only certain polar groups take part in the rotation and their freedom to rotate contributes towards polarisation has been further strengthened by these measurements.

Acknowledgment

The author is indebted to Dr. P. K. Bose, the Director of this Institute, for his kind interest in this work.

References

- ¹ Bhattacharya, G. N., *Ind. J. Phys.*, 1944, **18**, 1.
- ² Bhattacharya, G. N., *Ind. J. Phys.*, 1944, **18**, 159.
- ³ Rangaswami, M., and Sen, H. K., *Handbook of Shellac Analysis* (Ind. Lac Res. Inst.), 1942, 89.
- ⁴ Tschirch, A., and Koch, M., *Arch. Pharm.*, 1902, **240**, 202; *Abs. J. Chem. Soc.*, 1902, **82** (i), 478.
- ⁵ Barry, T. H., *Natural Varnish Resins* (E. Benn), 1932, 29.
- ⁶ Fuoss, R. M., and Kirkwood, J. G., *J. Amer. Chem. Soc.*, 1941, **63**, 385.

Letters to the Editor

YELLOW CLAY ASSOCIATED WITH THE BAUXITE OF PADARWARA (C.P.)

THE village of Padarwara is situated 3 miles south of Katni railway station on raised ground, and blocks of bauxite are exposed in the village and the houses are partially made of blocks of bauxite and laterite. There is hardly any literature on the occurrence of yellow clay and bauxite in this locality. The following reference occurs in Sir Cyril Fox's memoir¹: "Padarwara village itself stands on a small patch in aluminous laterite which if the village at any time were abandoned might be worth investigating." It may be noted that the position since Fox's visit has greatly changed. Originally, bauxite was observed in the Sumrar nala flowing to the east of Padarwara and it was gradually traced to the neighbourhood of the village. Apart from the village site, a considerable area has been proved by actual pits to contain good quality bauxite and yellow clay both north-east and west of the village. Messrs. S. P. Gaur obtained a mining lease in 1939 of 13 acres for 10 years on the north-east of the village. They have

already won some bauxite and 3,000 tons of yellow clay which they sold to Messrs. Olpherts Ltd., of Katni. Another firm prospected more than 30 acres of the ground on the west of the village with encouraging results and some bauxite was still seen lying in stacks. It may be noted that the actual area is likely to be still greater.

A little north-east of the village, the following important section was observed in descending order:—

Soil	1'
Laterite	about 2'
Bauxite	2' to 3'
Yellow clay	2' to 4'
Vindhyan sandstone	Base not exposed.

This section is peculiar and different from that exposed near Katni where limestone is observed to be the bedrock which is overlaid by whitish clay with reddish, brownish, yellowish and greenish streaks and the clay is overlaid by bauxite and laterite in places. It is noteworthy that the bedrock in this case is Vindhyan sandstone which is overlaid by yellow clay. In the upper portion of the yellow clay, bauxite is found intermixed

with it and sometimes blocks of bauxite are found embedded. Beautiful whitish pisolites, varying from the size of a pea to a walnut, are found distributed in this clay. The bauxite is pisolitic in texture.

The colour of the clay is variable. On the whole it possesses a yellowish colour but even in specimens streaks of lighter coloured material are to be observed. It soils the fingers pale yellow, while on powdering, it has a somewhat light earthy yellow colour. It is distinctly unctuous and definitely plastic. On calcining, the powder assumes a reddish tint.

A thin section of the yellowish clay is seen to consist almost wholly of yellowish brown to opaque brownish material under transmitted light, while under reflected light it shows a pale yellow colour owing to the staining of limonite with occasional reddish patches, when the coloration is due to hæmatite. In the clayey material some fine remnants of felspar with an occasional very tiny flake of muscovite are to be seen. It may be noted that quartz is practically absent, which evidently appears to have been removed by leaching. The felspar pieces have largely angular or subangular form, while a few of them possess prismatic outlines. It is noteworthy that in places concentric banding, circular or elongated in form, is to be observed which represents the initial stage in the formation of pisolites and oolites of bauxite. It will, therefore, be noted that pisolitic or oolitic structure has already commenced developing in the clay itself and that is why in the field pisolites or even blocks of bauxite are seen embedded in the clay.

The unwashed material when powdered and mixed with water in a beaker remains in suspension for a considerable time and imparts an earthy-yellow colour to the liquid, showing that the clay contains kaolin². The yellow clay was analysed at the Government Test House, Alipore, Calcutta; the analysis of the unwashed dried sample is as follows:—

SiO ₂	..	43.00
TiO ₂	..	1.95
Al ₂ O ₃	..	31.02
Fe ₂ O ₃	..	11.32
FeO	..	0.36
CaO	..	0.33
MgO	..	0.32
K ₂ O	..	0.45
Na ₂ O	..	0.25
P ₂ O ₅	..	Trace
CO ₂	..	Trace
SO ₃	..	0.26
Loss on ignition		10.90
		<hr/> 100.16

Besides, traces of copper, nickel, bismuth and manganese compounds were found. The moisture was 1.05. Compared to kaolin which theoretically contains 46.3 per cent. SiO₂ and 39.8 per cent. Al₂O₃, this clay is somewhat low in silica; the Al₂O₃ is also low, part of it being apparently replaced by Fe₂O₃. It will be observed that the amount of Fe₂O₃ is only 11.32 per cent. The material cannot be styled ochre, which according to Roger³ contains at least 15-20 per cent. Fe₂O₃. Some yellow ochres are known to contain 20-40 per cent. Fe₂O₃.

As a result of the microscopic study of this clay and of the specimens of fresh and decomposed Vindhyan sandstone collected from the base of this clay it appears that the clay is undoubtedly of residual origin formed from the decay of Vindhyan sandstones. The origin of this clay is similar to that of the residual clay observed in several quarries near Katni and derived from the weathering of the Vindhyan limestone, the only difference being that the clay derived from the limestone, low in its iron content, is mainly whitish in colour, while the yellow clay in question is derived from sandstone containing iron which has got concentrated to the extent of 11.32 per cent. Sir Cyril Fox has designated this clay as lithomarge. As bauxite is intimately mixed with this clay, the former must have originated as a result of further leaching of silica and also of iron so that the clay has been changed into bauxite.

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15th March 1946.

¹ Mem. G.S.I., 1923, 49, 119.

² Trans. Min. Geol. Inst. Ind., 1933, 28, 139.

³ Roger, *Industrial Chemistry* (D. Van Nostrand Co. Inc., New York), 1944, Vol. II, p. 967.

PREPARATION OF A HIGHLY ACTIVE VEGETABLE RENNET FROM *FICUS CARICA* LINN

ALTHOUGH the existence of milk clotting enzymes in several plant materials is known and some have been described¹⁻⁷, they have not found much application because of their relatively poor activity, appearance and smell. Junkets and cheese prepared out of them develop off-flavour and bitter taste, and consequently compare unfavourably with those prepared out of animal rennet. The proteolytic components of such enzymes have been studied in detail and much valuable information about the nature of their action has been collected. The milk clotting component has been considered to be part of the same enzyme system and has not, therefore, received any special attention^{8,9}.

We have recently found that the enzyme from the latex of *Ficus carica* Linn (the edible fig) can be obtained in a highly active form. It has several desirable features and holds out possibilities not only for the preparation of cheese and junkets but also in other types of food processing and in medicine.

The latex is very active to begin with, being anywhere from 30 to 100 times as active as the usual acid extract of calf stomach mucosa. The enzyme is prepared from the latex by direct drying, salting out or solvent precipitation, after removal of suspended matter by filtration or centrifuging. The resulting product is a white to pale yellow powder with an agreeable mild flavour. 1 c.c. of the latex yields 0.12 to 0.15 gm. of dry powder which retains 90 to 95 per cent. of the activity originally present in the latex. Freezing followed by quick drying under vacuum gives the best results. Salt precipitation with ammonium sulphate also gives a good recovery, but the final preparation contains 25 to 30 per cent. of salt. The salt can be removed by dialysis; but this is accompanied by loss of activity depending on the temperature of water used for dialysis (23 per cent. at 3 to 5° C. and 50 per cent. at 22 to 23° C.).

The activity of the latex is dependent upon environmental factors such as the season of the year, the time of the day, the age of the plant and the parts from which the milk is collected; but even allowing for these, enzyme preparations of quite high activity can be obtained. If processed rapidly, a preparation capable of clotting 25,000

times its own weight of fresh cow's milk in one minute at a temperature of 37° C. can be obtained. At the optimum temperature of 76° C. the activity is multiplied twelve times. A further 3.5 times increase in activity is observed on addition of calcium salts or lactic acid to the milk. Thus, at the optimum temperature and with addition of about 600 mgms. of calcium lactate per pound of milk, the enzyme is capable of clotting 1,000,000 times its own weight of fresh cow's milk in one minute. In actual production, it may not be possible to secure all these conditions so that some loss of activity is inevitable; however, a preparation having about two-thirds the above activity can be obtained.

The dry enzyme preparation keeps well; but the original latex, its filtrate or an aqueous extract of the dry enzyme loses its activity rapidly at room temperature (Ca. 20° C.). The enzyme extract can, however, be preserved in the ice chest for 20 to 30 days without appreciable loss in activity. The curd formed by the enzyme is somewhat soft and this renders it quite agreeable to taste. The extract contains a proteolytic component; but at the very high dilution at which the preparation is used in practice, the latter is hardly felt.

The yield of latex per plant is 30 to 50 c.c. at a time under local conditions; but the same plant can be milked a number of times in a season. The yield is highest in the early hours of the morning. Rainy or humid weather is favourable for high yields. Tapping during hot dry weather is injurious to the plant.

The properties of the enzyme, the kinetics of its action, response to different substrates and other related studies have been completed and will be published shortly. The purification and study of the chemical nature of the enzyme is in progress.

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Bangalore, 16th Nov. '45.

- ¹ Lea, *Proc. Roy. Soc.*, 1883, **36**, 55.
- ² Martin, S. H. C., *J. Phys.*, 1885, **6**, 340.
- ³ Hansen, *Pharmacographia Indica*, 1885, **3**, 344.
- ⁴ Chodat and Ronge, *Central Blatt Bakt.*, 1906, **2**, 1, 16.
- ⁵ Green, *Annals of Bot.*, 1893, **7**, 112.
- ⁶ Christen & Virasoro, *Le Lait*, 1935, **15**, 354.
- ⁷ Yeshoda, K. M., *Curr. Sci.*, 1941, **10**, 23.
- ⁸ Balls & Hoover, *Contribution*, 465, from Food Res. Div., U.S. Agr. Chem. & Eng.; *J. Bioi. Chem.*, 1937, **121**, 737; *Ibid.*, 1940, **130**, 669.
- ⁹ Narain & Singh Atam, *Ind. J. Vet. An. Husb.*, 1942, **12**, 224.



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THE INDIAN PLASTICS INDUSTRY

RECENT developments in the Indian plastics industry have been surveyed in a series of articles appearing in this issue. War shortages created an atmosphere favourable for new ideas; the ideas were tested in the laboratory and the practicability of the more promising ones proved on a commercial scale. The survey gives an account of a number of hopeful approaches and a sober assessment of the difficulties encountered.

To dilate on the importance of the plastics industry to India is to indulge in platitudes. As a material of construction, plastics have replaced, to a notable extent, the traditional materials like wood, metals and porcelain. In times of emergency, they render the nation independent of many essential raw materials. Through the application of mass-production methods, a large assortment of utility and decorative articles have been produced economically from plastics. By selecting the plastic or the filler or both, the properties of the resulting product can be varied over a wide range to meet an amazingly large number of exacting requirements of the engineering, electrical, optical and other important industries. Thus, combination with textile fabrics augments the mechanical impact strength; asbestos increases heat resistance and mica improves insulating properties. The replacement of carbon by silicon in the structural "backbone" of the plastic resin has led to the production of a new and revolutionary class of insulating materials—the silicones—possessing thermal stability approaching that of inorganic compounds. New developments in materials,

processes and applications are taking place with bewildering rapidity. An industry which can meet such a variety of demands must be highly rated among the industries of a nation.

An appraisal of the raw material resources is of value in determining the scope for the development of the industry. The three principal sources of raw materials for plastics are coal, petroleum and agricultural and forest products. The basic raw materials required for the manufacture of thermosetting resins of the bakelite class and nylons are coal-tar distillation products. The tar distillation industry in India has not been sufficiently or efficiently organized to warrant the establishment of a plastics industry based on coal-tar products. Indian resources of petroleum are not large enough to provide the raw materials and the intermediates required for synthetic plastics. Calcium carbide which is one of the important source materials for plastics, is not produced in this country. It is clear that the absence of fully developed coal-tar, petroleum and calcium carbide industries in India stands in the way of developing synthetic plastics based on the products of these industries. The utilization of materials derived from the abundant resources of farms and forests, however, has great possibilities. The application of chemurgy—or study of processes for the conversion of farm wastes and surpluses into the raw materials of the chemical industry—provides the means for obtaining the basic raw materials and intermediates required. Thus cellulose acetate, which is by far the most important thermoplastic, is

obtained from cotton linters. The chemicals required are acetic acid and acetic anhydride, both of which are derived from alcohol obtained by the fermentation of molasses. It will be evident that the prospects for developing a cellulose plastics industry in India are promising, as her resources both in cotton and molasses are substantial. The phenolic constituent, cardanol, from cashew shell liquid, and bhlawanol from the common marking nut, constitute valuable starting materials for the production of resins useful in insulating varnishes, stoving enamels, cold setting filling compositions and cements, flooring and lining materials, and so on. Furfural, which is employed in the production of thermosetting resins, can be obtained from bagasse and other industrial wastes. Sebacic acid and hexamethylene diamine, both important nylon intermediates, can be obtained from castor oil. Apart from the possibility of obtaining the basic raw materials from wastes and surpluses, it is possible to obtain plastic materials by suitably processing several natural products. The versatile natural resin, lac, can be modified to give plywood adhesives, coating compositions, insulating materials and a large number of other products. Several materials, processes and applications have been discussed in the symposium of papers published in this journal. Considerable progress has been made in the development of plastics based on chemurgic products and rapid advances may be expected in the near future.

The modern plastics industry is not merely a matter of materials; it is also a matter of technique. The design and fabrication of machinery required for handling the varying types of plastics are of the utmost importance

to the growth of the industry. Considerable work on mould design and moulding technique has been carried out in the Physical Laboratories of the *Council of Scientific and Industrial Research*, which has led to significant developments in the manufacture of containers from laminated stock. The pace of development of the Indian plastics industry will be greatly influenced by the development of engineering equipment. A genuine competition of ideas and products is essential for development, and *entrepreneurs* have in the field of plastics immense scope for initiative and originality.

We have already stated that many of the raw materials required for establishing a stable plastics industry in India can be obtained from the farm and forest resources available in the country. With the development of the Indian chemical industry, the range of plastics that can be produced will be considerably augmented. The *Council of Scientific and Industrial Research* has given a great impetus to research and development in this field. There has been a growing appreciation in this country of the importance and possibilities of plastics and several manufacturing industries have been established. Figures for the production of plastic materials are not available, but the total volume must be very small in comparison with the market demand. The United States of America produced 95,000 tons of plastics in 1937, and 420,000 tons in 1942. The production per head of population even in 1937 was 1.45 lb. On the basis of 1 lb. per head of population in India, the total requirements work out to about 180,000 tons. No one can doubt the rich future for the industry, but it can be assured only as the result of intensive research.

Recent Developments in Plastics in India



I—INTRODUCTION

By S. S. BHATNAGAR

DURING the war, India experienced an acute shortage of many essential materials, e.g., metals and metallic products, electrical insulators. The development of the Indian plastics industry with particular reference to its research aspect was thus influenced by the need to find indigenous substitutes for imported materials. This development was naturally governed by the availability of raw materials in the country, although we were aware of the new and fascinating developments in the field of synthetic resins such as nylon, prolon, silicones and polythene.

The synthetic resin industry can be developed in India only in stages. The first step, namely, the fabrication of moulded articles from imported powders, has been established to some extent, and of the well-known firms engaged in this work may be mentioned: *Bestolite Moulding Co.*, *India Moulding Co.*, *Indian Plastics Co.*, *Plastics Products Ltd.*, *Government Electric Factory (Bangalore)* and *Kay Engineering Co.* The next stage is the development of the chemical industry which will supply the various essential chemicals required in synthetic resin manufacture such as formaldehyde, phenol, urea, phthalic anhydride, furfural, different esters and alcohols. Although some progress has been made in building up an Indian chemical industry, various limitations such as the unavailability of cheap raw materials, plant and machinery and absence

of State support in the initial stage have unfortunately hindered the vast developments which are essential for the growth of the synthetic resin industry. In our attempts to develop this second stage, we have made certain efforts quite successfully. Perhaps the most notable contribution which may be mentioned is the manufacture of phthalic anhydride from naphthalene. This process was for the first time introduced in India by the *Shalimar Tar Products, Ltd.*, as a result of the investigations carried out in the laboratories of the *Council of Scientific and Industrial Research*, upto the pilot plant stage. These investigations were largely financed by the firm, which has already installed a semi-commercial plant at Calcutta. The production of furfural from bagasse, paddy husk and other cellulosic wastes was successfully worked out in the same laboratories. A pilot plant has also been set up at Bangalore for the production of formaldehyde from methyl alcohol and another pilot plant is to be obtained for investigations in the catalytic synthesis of formaldehyde from water gas. Another interesting investigation carried out in the laboratories of the *Council of Scientific and Industrial Research* is the making of nylon and glyptal types of resins starting with sebacic acid obtained by high temperature cracking and polymerization of castor oil and castor oil products. Investigations on the manufacture of urea and melamine have also been carried

manufacture of moulded or cast articles. Their importance is mostly in the field of coatings. Barron, in his book *Modern Plastics*² mentions some of their applications. They are:—

- (1) Air drying enamels,
- (2) Tin coating,
- (3) Printing inks,
- (4) Stoving enamels,
- (5) Metal primers and finishes,
- (6) Car finishes,
- (7) Coated fabrics,
- (8) Aircraft lacquers, and
- (9) Marine paints.

The coating compositions can be modified by phenolic resins, urea resins, drying oils³ and natural resins⁴ to give products having widely different characteristics and industrial applications.

When condensed with certain monobasic acids, polyhydric alcohols yield esters which find application as emulsifying and wetting agents, as plasticizers and synthetic waxes. They can be nitrated to give explosives. Glycol is employed as antifreeze. Sorbitol is used in the manufacture of printers' rolls and as a conditioning agent for textiles and paper and for softening skins in the tanning industry. It is also used for the production of synthetic vitamin C. Sorbitol and mannitol are employed in medicine as laxatives and diuretics. The use of sorbitol was suggested in Germany as a diabetic food.

The methods that can be employed for the production of synthetic polyhydric alcohols are:—

- (1) Reduction of corresponding monoaldehydes or ketoses with the help of sodium or aluminium amalgam⁵,
- (2) Catalytic reduction of monoaldehydes or ketoses under pressure and at high temperature in the presence of Al-Ni catalyst⁶, and
- (3) Electro-chemical reduction of monoaldehydes⁷.

None of these methods is commercially employed for the manufacture of glycol, glycerol and pentaerythritol which, as is well known, are obtained from ethylene gas, soap manufacture and formaldehyde cum acetaldehyde respectively. These methods are, however, applicable for the preparation of mannitol and sorbitol. Of these, the last method which was studied in detail by Creighton in America with respect to the reduction of glucose, is being studied in the

Laboratories of the Council of Scientific and Industrial Research. The raw materials which are being examined are molasses and carbohydrates other than pure glucose. Experiments with pure glucose show that low acidity or alkalinity of the catholyte favours the production of sorbitol, while high alkalinity leads to the formation of a mixture of mannitol and sorbitol. Good yields of sorbitol and mannitol have been obtained with pure glucose using chemical lead as electrodes.

Table I gives details of the experimental conditions. If metals other than chemical lead are used as electrodes, the current efficiency is adversely affected as will be seen from the figures given in Table II.

TABLE I. *Electrolytic Reduction of Glucose*

Weight of glucose	280 gms.
Concn. of glucose	325 gms./litre
Temperature	20°–24° C.
Current density, amp./sq.dm	1.01.
Duration of electrolysis, hrs.	61.
Weight of sugar consumed	243 gms.
Weight of sorbitol	183 gms.
Weight of mannitol	28.5 gms.
Total hexahydric alcohols	211.5 gms.
Ratio, wt. of alcohol/wt. of sugar consumed	0.87.
Current efficiency, %	51.1

TABLE II. *Current Efficiency with Different Electrodes*

Anode	Amalgamated cathode	Current efficiency %
64 % lead	64 % lead	...
97 % lead	97 % lead	...
Assay lead	Assay lead	1.9
Assay lead	Zinc	4.5
Tin	Zinc	33.5
Chem. lead	Chem. lead	51.5

References

- ¹ Kienle, *Ind. Eng. Chem.*, 1933, **25**, 971; Kienle and Schlinghman, *J. Soc. Chem. Ind.*, 1936, **55**, 228 T; Weisberg, *U.S.P.* 1,413,144 (1922)
- ² *Modern Plastics*, Harry Barron, 1945, p. 557.
- ³ Baird and Hill, *B.P.* 364,737 (1932); Walker and Bill, *B.P.* 318,003 (1930); Wright and Bartlett, *B.P.*, 235,589 (1926).
- ⁴ Ellis, *U.S.P.* 1,722,566 (1930); *U.S.P.* 2,063,540.
- ⁵ *Ber.*, 1876, **9**, 1465; 1883, **16**, 3010; 1892, **8**, 539; *J.C.S.*, 1924, p. 2474.
- ⁶ *C. A.*, **37**, 655.
- ⁷ Creighton, *Trans. Electrochem. Soc.*, 1939, p. 289.

(b) PHTHALIC ANHYDRIDE

By N. GHATAK,

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PHTHALIC anhydride, $C_8H_4O_3$, is one of the important intermediates required in a number of chemical industries. It

condenses with glycerol and other poly-hydroxy alcohols yielding resinous compositions, commercially known as 'glyptal' or 'alkyd' resins. These resins are mostly used for making lacquers and protective coatings. When modified with drying oils, or with natural, phenolic or urea resins, they find very wide applications in industry. Alkyd coatings give high gloss, good adhesion, good resistance to weathering and long life protection at a reasonable cost. They are used for wood, metal and materials of construction in general.

Phthalic anhydride is not only a primary material for making alkyd resins, but it is also used in the production of plasticizers, many of which are essential ingredients in plastic compositions. The anhydride is also used in the manufacture of synthetic indigo and the pyronine and triphenylmethene class of dyestuffs.

The anhydride is produced by controlled oxidation of naphthalene. The sulphuric acid oxidation of naphthalene in presence of mercuric sulphate has been replaced in recent years by the vapour phase oxidation by air in the presence of vanadium catalyst. In 1941 the U.S.A.¹ alone produced 128 million lbs. of alkyd resins based on phthalic anhydride, whereas, the quantity produced some 15 years before, in 1925, was almost nothing. The anhydride was derived from 55 million lbs. of naphthalene obtained from 24 million tons of coal.

India produces approximately one thousand tons of naphthalene annually, which is mostly used for making moth balls. Considering the urgent need for the economic and profitable disposal of the hydrocarbon, the Council of Scientific and Industrial Research in 1941 undertook an investigation on the production of phthalic anhydride. A pilot plant² was developed for the vapour phase oxidation of naphthalene. In this process mercury, which is employed as the heat transferring medium in the British and American plants, has been replaced by a mixture of salts as mercury is not available in the country. The process which is covered by a patent³ has been divulged to Messrs. *Shalimar Tar Products, Ltd., Calcutta*, who have now commenced the commercial manufacture of phthalic anhydride.

The heat transfer medium consists of a mixture of sodium nitrite (40 per cent.), sodium nitrate (7 per cent.) and potassium nitrate (53 per cent.). Vanadium pentoxide

anchored on small aluminium pieces having rough and jagged surfaces has been found to be the best catalyst. The recent discovery of vanadium-bearing ores (vanadium 2 to 7 per cent.) by the *Geological Survey of India* in the Singhbhum District of Bihar, is of great interest to this industry for meeting the requirements of the catalyst. The reaction chamber for the oxidation of naphthalene consists of square iron tubes $\frac{7}{8}$ " square cross section \times 22". Each tube is capable of producing 1 lb. of phthalic anhydride in 24 hours. The optimum conditions calculated per tube per hour, are as follows:

Volume of primary air	118 litres
Volume of secondary air	128 litres
Naphthalene vapour oxidized ..	19.6 gms.
Temperature of molten naphthalene	100° C.
Temperature of the mixing chamber ..	300° C.
Temperature of the catalyst column	425°-430° C.
Phthalic anhydride obtained	18.5 gms.
Yield of phthalic anhydride	81.6 per cent.

References

- ¹ *Modern Plastics*, by Harry Barron, 1945.
- ² *J. Sci. & Ind. Res.*, 1943, **1**, 90.
- ³ *Indian Patent No.* 29,374 (1943).

(c) RAW MATERIALS FOR NYLON MANUFACTURE

By KARIMULLAH

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NYLONS are obtained by the condensation of aliphatic dicarboxylic acids with aliphatic diamines.

Hundreds of nylons can be prepared by using different dicarboxylic acids and diamines, but only a few of them are of commercial interest. The more important raw materials are sebacic, adipic and methyladipic acids, and hexamethylene and decamethylene diamines. Adipic¹ and methyl adipic acids are manufactured from phenol and cresol by high pressure catalytic hydrogenation and subsequent oxidation of cyclohexanol and methylcyclohexanol so formed. Cyclohexanol can also be prepared from cyclohexane, a compound readily available from certain petroleum fractions. Sebacic acid is obtained from castor oil by a simple process of fusion with caustic soda. The diamines are derived from adipic and sebacic acids by passing a mixture of the acid and ammonia over a dehydration catalyst at high temperature which results in the formation of the corresponding nitrile. The latter can be catalytically hydrogenated to the diamine.

Another method for the preparation of hexamethylene diamine is the catalytic hydrogenation of ϵ -caprolactam, a convenient source of which is again castor oil (through heptaldehyde).

The raw materials required for the manufacture of nylon intermediates are phenol, cresol, certain petroleum fractions and castor oil. The petroleum resources of India, comparatively speaking, are meagre. Phenol, benzol and cresols are products of coal tar distillation. Out of the 30,000,000 tons of coal mined annually in India, only 3,000,000 tons are subjected to dry distillation². The amount of tar recovered is 80,000 tons, of which nearly 40,000 tons are distilled further³ for the production of aromatic compounds, yielding roughly 1,000 tons of benzol and 800 tons of phenol. Taking into account the demands of various industries such as explosives, dyestuffs, fine chemicals and pharmaceuticals, there is hardly any surplus for the production of nylon. There is indeed great scope for the expansion of the coal tar distillation industry in India, but at present there is little prospect for a nylon industry based on coal tar products.

The position is different if castor oil is used as the raw material for the production of nylon intermediates. India produces about 200,000 tons or 80-90 per cent. of the total world production of castor seeds. The area under cultivation, at the present time, is about 2,000,000 acres. This can easily be increased as there are huge tracts of waste and sandy soil suitable for the cultivation of castor plant in India.

Investigations have been carried out in the Laboratories of the *Council of Scientific and Industrial Research* on the conditions of temperature, pressure, type of alkali, duration of reaction, etc., for the optimum production of sabacic acid from castor oil. Capryl alcohol is recovered as a by-product. The results obtained so far have justified the continuation of the work on a pilot plant scale. It may be stated on the basis of the work carried out, that the production of nylon intermediates from castor oil is a commercial possibility. There are, however, several technical problems to be tackled before nylon type of resins can be produced from castor oil.

References

- 1 Aronov, U.S.P. 2,191,786.
- 2 J. Ind. Chem. Soc., Ind. & News Ed., 1943, 6, 83.
- 3 Sci. & Cult., 1943-44, 9, 279.

2. MANUFACTURE OF SYNTHETIC PLASTICS AT BHADRAVATI*

By S. RANGA AYENGAR

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ABOUT one ton of moulding powder in the desired shades is being produced on a pilot plant scale and supplied every month to the *Government Electric Factory* at Bangalore. The process consists in the condensation of phenol or cresol with formaldehyde in the presence of ammonia as catalyst under controlled conditions. The mixture of equimolecular proportions of phenol and formaldehyde (12 lbs. of phenol and 10 lbs. formaldehyde) and 2 per cent. ammonia is charged into a reaction kettle made of copper with a reflux condenser and an efficient stirring arrangement. In the first stage, the reaction is allowed to proceed at 90° C. for 50-55 min. when an oily resinous layer separates leaving an aqueous layer on the top. The water released during the condensation along with that introduced with formalin is removed slowly by applying a vacuum of 8"-10", the temperature being maintained at 80° C. Samples of the liquid resin are drawn from the bottom of the kettle at intervals for testing. When a sample cooled under water no longer exhibits a curdy appearance and is transparent on cooling, the charge is emptied into an open vessel. The product is then heated to 100° C. in a steam bath with 1 per cent. hexamethylene tetramine and when the resin begins to froth and polymerize (A stage) it is poured into shallow trays. A sample of this resin on cooling should be transparent or translucent and brittle. It is cured for some time in a hot air oven (90° C.) so that it hardens on cooling and can be ground into a fine powder. The quantity of resin obtained per charge is about 14 lbs.

In the next stage, the resin powder (40 mesh) is mixed with a filler, dyestuff and other ingredients for the manufacture of moulding compositions. Soft wood, free from oil, is disintegrated to a fine (80 mesh) powder in a "C. & N." type disintegrator. Spent sandal (*Santalum album* Linn.) wood has been selected for making dark shades, while *Bende* (*Kydia calycina*) wood is used

* From a paper read at the *Indian Science Congress*, Bangalore, 1946.

for lighter shades. Special fillers like asbestos and mica have also been used when desired, to impart heat resistance and good electrical insulation. A typical composition consists of the following:—

50 parts of resin (binder)
50 ,, of wood flour (filler)
2 ,, hexamine (accelerator)
0.75 ,, dyestuffs
1 ,, stearic acid (lubricant)
0.35 ,, plasticizer
1 ,, catalyst (MgO or CaO)

The ingredients are weighed and mixed in a ball mill for 8 hours. The powder discharged from the mill is passed through hot blanketing rolls, heated internally by steam and rotating in opposite directions. The binder undergoes progressive polymerization to the 'B' stage. The time of passage through the hot rolls is carefully regulated as the curing time and flowing properties of the product are determined by the extent of polymerization. The blanket is ground to a granular powder. When moulded under heat (150-160° C.) and pressure, the resin passes on to the permanently hard, infusible state, 'C', in which stage the article can be easily detached from the mould.

Formaldehyde

Formaldehyde, one of the major raw materials, is being manufactured in a small plant (2 units of 3 tons capacity each per month) from C.P. methanol obtained from wood distillation. The equipment consists of an arrangement for supplying compressed air, an alcohol vapourizer, catalyst chamber, condenser, scrubber and a fractionating column. A mixture of methanol vapour and air in suitable proportions is passed through the catalyst chamber containing copper gauze heated to 300° C. The catalyst is maintained at a dull red heat. The temperature being controlled within narrow limits, as otherwise secondary reactions take place.

The gaseous products from the catalyst chamber are passed through a condenser and a scrubber for recovering unreacted methanol and formaldehyde. The crude product so obtained contains 25-30 per cent.

formaldehyde and is concentrated in a suitable column, the unreacted methanol being recovered and recycled. The final product contains 10-25 per cent. methanol and upto 0.5 per cent. formic acid.

Furfural

A pilot plant for the production of furfural from paddy husk and sugarcane bagasse, has been set up at Bhadravati. The process consists in digesting the raw material with dil. sulphuric acid under pressure in a lead-lined digester, when the pentosans present are converted to furfural. The conditions for obtaining optimum yield are:

Ratio of raw material:

dilute sulphuric acid .. 1:0.3

Strength of acid .. 5 per cent.

Duration of digestion .. 2 hrs.

Quantity of distillate .. 250 lbs. per
charge of
50 lbs.

Pressure (steam) .. 65-70 lbs.

with efficient mixing of acid and the raw material, the average yield of furfural was 50-55 per cent. of the theoretical. The maximum concentration of furfural was 6.5 per cent. in the distillate, and by concentration in a specially designed fractionating column, a product of 95-96 per cent. purity has been obtained, which can be redistilled to give 100 per cent. furfural. The complete equipment was designed and fabricated locally and about 35 lbs. of furfural (95 per cent.) are now being produced every month. Furfural-phenol, and furfural-cresol resins are now being produced on an experimental scale.

Hexamethylene tetramine

Hexamethylene tetramine or hexamine which is a very important hardening agent and accelerator in the manufacture of phenolic thermosetting moulding powders, is now produced at Bhadravati to meet requirements. Anhydrous ammonia is reacted with formaldehyde until the resultant solution is alkaline to phenolphthalein. The solution is slowly evaporated to dryness when hexamine separates out.



III. NATURAL RESINS

1. SHELLAC AS A MOULDING PLASTIC

By S. RANGANATHAN

(Indian Lac Research Institute, Ranchi)

SHELLAC is one of the oldest plastics known to mankind and took its place in industry shortly after hard rubber and bitumen mouldings, excelling them in every respect. As the base for gramophone records it has not been approached even to this day by any synthetic resin. In India, lac bangles, which may be considered as the forerunners of the modern costume jewellery made of cast resins, were known from very early times. Moulded shellac caskets were made in England in 1876¹. Gardner² and Merrick³ patented shellac compositions for plastics in 1868. During the period 1890-1910 the shellac gramophone record was perfected. The next decade saw the development and use of shellac mouldings in the electrical industry with such a wide variety of fillers like asbestos, mica, kaolin, barytes, paper pulp, etc. Synthetic resins have not been able to replace shellac to any considerable extent in gramophone records, micanite, laminated insulations, abrasive wheels, etc.

The greatest need for improvement in shellac plastics lies in increasing the heat-resistance and alkali-resistance and conferring thermo-hardening properties. Several patents have been filed in the U.S.A. for improving the heat-resistance of shellac mouldings, notably by Daniels and Snell⁴. A list of chemicals that improve heat-hardening have been investigated by Ranganathan and Aldis⁵. Dry-mixed shellac compositions that possess improved heat-resistance have been described by Gardner⁶, wet-mixed compositions containing urea by Ranganathan⁷, and a composition that can be worked almost like the thermohardening phenolics, by Venugopalan and Sen⁸. Thermoplastic compositions for jute laminated boards⁹, and those containing horn powder¹⁰,

etc., have also been developed in India during the war.

Shellac, although a thermoplastic like cellulose acetate and acrylic and styrol resins, does not possess their toughness for injection moulding, but the addition of fibrous fillers improves it to a certain extent for the manufacture of switches, small containers, etc.^{10, 11}.

The future for shellac plastics in India will be bright in dry-mixed compositions containing accelerators, fibrous fillers and pigments are commercialized as thermoplastic materials of improved heat resistance.

References

- ¹ R. W. Rowell, *Technology of Plastics*, 1936.
- ² J. Gardner, *U.S.P.*, 73,088 (1868).
- ³ J. M. Merrick, *U.S.P.*, 85,018 (1868).
- ⁴ E. A. Daniels and H. S. Snell, *U.S.P.* 1,673,803-8 (1928).
- ⁵ S. Ranganathan and R. W. Aldis, *Ind. Lac. Res. Inst., Bull.* 14, 1933.
- ⁶ W. H. Gardner, *British Plastics*, 1935, **6**, 524, 571.
- ⁷ S. Ranganathan, *Ind. Lac. Res. Inst., Bull.* 30, 1938.
- ⁸ M. Venugopalan and H. K. Sen, *British Plastics*, 1939, **10**, 626.
- ⁹ S. S. Bhatnagar, *et al.*, *Ind. Pat.* 28277 and 28281 (1941).
- ¹⁰ S. S. Bhatnagar, *et al.*, *Ind. Pat.* 31282 (1944).
- ¹¹ S. Ranganathan, *Ind. Lac. Res. Inst., Res. Note* 19, 1938.
- ¹² Y. Sankaranarayanan and H. K. Sen, *Proc. Inst. Chem. (India)*, 1941, **13**, Part IV.

2. GUMS AND RESINS

By S. V. PUNTAMBEKAR

(Forest Research Institute, Dehra Dun)

THE forests of this country produce a variety of resins, oleo-resins, gum resins and gum oleo-resins, some of which are already important raw materials for many industries. The resin portion of all these natural resinous substances, known as "gums" in commerce, could be readily isolated and processed to yield desirable binders for plastics. In a few cases like lac,

TABLE I. *Indian Natural Resins for Plastics.*

Resin	Bot. name of parent tree	Locality	Specific gravity	Melting point, °C.	Acid value	Sap. value	Ester value	Ash	Remarks.
1. Rosin	<i>Pinus longitolia</i> <i>P. excelsa</i> <i>P. khasya</i>	Southern slopes of Himalayas, 2,000-10,000'	1.067	75-85	165	190	25	0.125	
2. Sal dammar	<i>Shorea robusta</i>	Sub-mountainous region, Dehra Dun to Assam and to C.P.	1.097-1.123	150-175	24.4	51.2	26.8	..	
3. Black dammar	<i>Canarium strictum</i>	West Coast, mostly Madras and Travancore	....	110	28-30	....	....	1.0-3.5	
4. White dammar	<i>Vateria indica</i>	Western Ghats, Kanara to Travancore	....	....	23.2	55.0	31.8	....
5. Boswellia resin	<i>Boswellia serrata</i>	Common on dry hills throughout India	1.068	75	39.7	66.3	26.3	....	Constitutes 55 per cent. of Indian frankincense or gum oleoresin of <i>B. serrata</i> .
6. Gurjan resin	<i>Dipterocarpus turbinatus</i>	Bengal, Assam and Andamans	....	....	14.4	....	....	....	Constitutes 35 per cent. of gurjan oil or gurjan balsam.

colophony, etc., the resins are directly used for this purpose but usually they are either esterified with polyhydric alcohols or fatty acid glycerides to increase their gloss, durability, drying power, resistance to water and alkalis, etc.; or are combined with phenol-formaldehyde condensation products to give a class of oil-soluble binders known as *Albertols* or *Amberols*; or are compounded with phthalic anhydride-glycerine or urea-formaldehyde condensation products to produce other useful binders. Dammar resins, in general, have been found to impart to plastics very desirable moulding characteristics as well as light colour, and have been utilized in the preparation of injection moulded articles, moulding powders and rubber compositions.

Indigenous natural resins that are available in commercial quantities and that could be considered for the plastics industry are colophony or rosin, sal dammar, black dammar, white dammar, *Boswellia* resin and *gurjan* resin. Table I gives their physical and chemical properties, source, locality, etc.

3. LIGNIN PLASTICS

By D. NARAYANAMURTI

(Forest Research Institute, Dehra Dun)

BOTH farm and forest offer enormous quantities of lignin for the chemical industry. "Billions of tons of it are present in the woods, at all times and supply renews itself indefinitely by natural growth." The woods, saw mills and plywood mills waste, pulp and paper mills waste, lignin from wood saccharification plants, bagasse and other agricultural wastes, form the chief sources of lignin and no wonder an enormous amount of work has been done on the utilization of this material for plastics.

The *Forest Products Laboratory, Madison*, has developed various types of lignin plastics by pretreatment of wood¹. Sawdust is digested with dilute acid or aniline and the resulting digested mass drained free of liquor, washed, then dried and ground. It can be plasticized with furfural and aniline and used for moulding at 150° C. Addition of 15 per cent. of phenolic resin to the aniline, furfural plasticized powders greatly increases the mould flow and makes the resin completely thermosetting. If chips are used for hydrolysis, they can be reduced to a pulp after treatment and converted into

sheets which can be laminated (with or without addition of phenolic resin) to boards.

By treating Scholler lignin with zinc sulphate or zinc oxide and reducing the reaction product with hydrogen sulphide, Sieberlich² has obtained a material which can be moulded at 2,000 lbs./sq. in. at 300° F. for 3 minutes.

Hydrolysed ligno-cellulose when combined with phenolic resins (3:1) has been found to yield satisfactory moulding compositions³.

Masonite and Benalite produced by the Masonite Corporation are examples of using "unextracted lignin"⁴. These are prepared from wood chips by a "thermal hydrolysis" treatment with steam of up to 1,200 lbs./sq. in. for a few seconds, followed by "explosion" of the wood. The process is based on the release and activation of lignin. A modification of the process yields a material that can be powdered and moulded. "Shellerite"⁵ is a similar plastic produced from redwood waste cooked with steam at high pressure and moulding the pulp with or without addition of other constituents.

Various attempts have been made for the utilization of sulphite waste liquor⁶. Wood waste cooked with sulphite waste liquor under pressure yields a "lignin enriched filler" which can be compounded with 20-30 per cent. phenolic resin, ground and used for moulding.

Condensates of alkali lignin with amines have also been found to yield resins suitable for varnish constituents⁷.

Various agricultural wastes like bagasse, corn stalks, etc., have been subjected to hydrolytic treatments as with wood for the production of plastics. The lignin content of these materials (12-25 per cent.) is not high. The main obstacles to their commercial exploitation have been their slower and less uniform curing properties⁸.

Despite the fact that large quantities of lignin are available and there has been a shortage of other raw materials (especially during the war) the use of lignin in plastics has not been extensive. This is to be attributed to the fact that (a) it has been an elusive material. Even though it is over a hundred years since it was discovered, its constitution is not yet firmly established, (b) it is not available as a raw material of constant properties, and (c) for the same price lignin plastics are neither better than synthetic plastics nor do they possess any unique properties. They are also dark

coloured. During recent years it has been debated whether lignin is an economic liability or a chemical asset. It is hoped that the combined efforts of the chemist and the engineer may contribute in transforming it into a valuable raw material for the plastics industry.

References

- 1 Guss, C. O., *F. P. L. Report*, 1945, 1481.
- 2 *Chem. Ind.*, 1945.
- 3 Katzen, *et al.*, *Ind. Eng. Chem.*, 1942, **34**, 314; *Tran. Amer. Chem. Eng.*, 1942, **38**, 735.
- 4 Boehm, *Mod. Plastics*, 1937, **15**, 26; 1939, **17**, 65.
- 5 Dawis, M. F., *Mod. Plastics*, 1943, **20**, 91, 134.
- 6 Howard, G. C., *Mod. Plastics*, 1939, **17**, 96; Meiter J. B., *Mod. Plastics*, 1942, **19**.
- 7 Phillips M. & Weihe M. O., *Ind. Eng. Chem.*, 1931, **23**, 286.
- 8 *Vide*, e.g., Sweeney, O. R., *et al.*, *Mod. Plastics*, 1941, **19**, 70; Clark, T. F. and S. I. Aronorsky, *Mod. Plastics*, 1944, **22**, 162; Clark, T. F., *et al.*, *Mod. Plastics*, 1945, **23**, 158.

4. PROTEIN PLASTICS—SEEDS AND SEED CAKES

By B. N. SIKKA

(Council of Scientific and Industrial Research, Delhi)

WAR-TIME scarcities gave an impetus to efforts for the utilization of annual farm crops as raw materials for plastics. Attempts have been made to produce low cost moulding compositions from such agricultural products as soya beans, coffee beans, seed cakes, bagasse, etc.

Plastics from Soya Beans.—Soya beans contain about 40 per cent. protein. The protein is rendered thermoplastic when hardened by formaldehyde at pH 4.1-4.3. Owing to the rather high water absorption, dimensional instability and poor flow of the plastics from formaldehyde hardened protein, the present practice is to incorporate it (or the meal itself) with phenol-formaldehyde resin², whereby a thermosetting resinous moulding plastic with greatly improved water-resistance, strength and other moulding qualities is obtained.

Proteinous cotton seed meal has similarly been suggested as a modifier for phenolic resins.

Plastics from Coffee Beans.—Extensive work at the H. S. Polin Laboratories, New York, has led to the production of a new type of plastic, called Coffelite³ from the surplus coffee bean crop. At the request of the Coffee Planters' Association, the Council of Scientific and Industrial Research carried

out investigations on the manufacture of moulding powders from coffee beans.

Coffee bean meal is rendered oil-free by solvent extraction. The meal is then digested under pressure with aniline or cresylic acid along with a small quantity of sulphuric acid. The insoluble matter is thoroughly washed, dried and ground to a fine mesh. The powder after the addition of a suitable plasticizer is moulded at 150°-160° C. and under a pressure of about 1 to 1½ tons per square inch. By slightly modifying the process, it has been possible to get a moulding powder from coffee husk, a waste product of the coffee industry. The articles moulded from the husk product were found to possess improved mechanical strength and water resistance. The moulded articles take a nice finish, are tough and possess besides good resistance to water and heat, excellent electrical properties (Dielectric constant = 8.2).

Plastics from Seed Cakes.—Extensive work has been carried out in the Council Laboratories on the preparation of plastics from groundnut seed cakes. Efforts in this direction have met with success in the production of opaque as well as translucent moulded articles.

References

¹ Brother and McKinney, *Ind. & Eng. Chem.*, 1938, **30**, 1236.

² Brother and McKinney, *Ind. & Eng. Chem.*, 1940, **32**, 1002.

³ C. A., 1939, May, p. 39.

5. BHILAWAN SHELL LIQUID

By S. SIDDIQUI

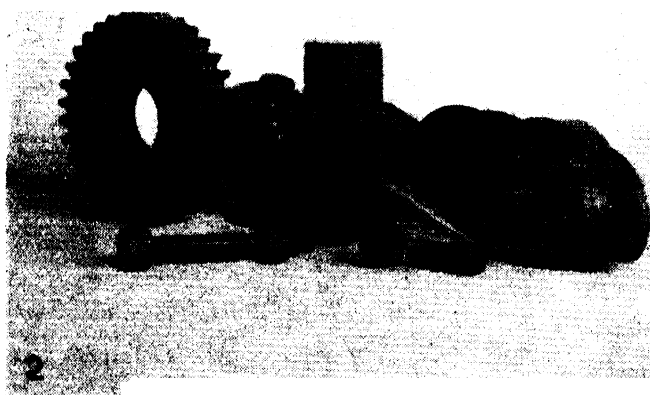
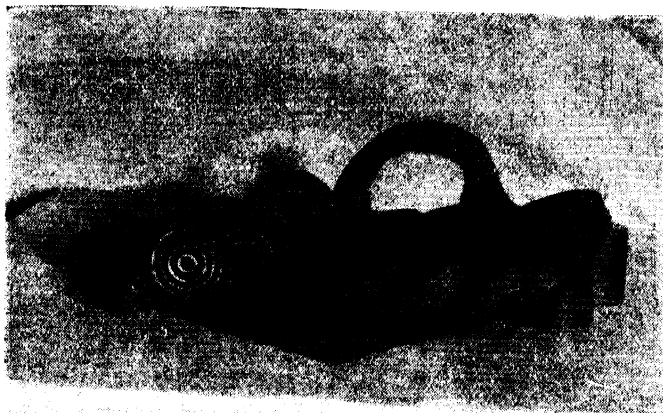
(Council of Scientific and Industrial Research, Delhi)

BHILAWAN, *Semecarpus anacardium* linn., gets its popular English name, "marking nut," from the fact that the Indian washermen use its juice for marking linen. The bhilawan tree grows under forest conditions in Central and Southern India and all along the sub-Himalayan tract and is also found in other hotter parts of the country. The darkish juice occurring in the honeycomb structure of the pericarp of the nut is a strong vesicant. In dilution with butter or emollient oils it is employed externally in the treatment of skin affections and internally in rheumatic complaints, epilepsy and nervous debility¹. Studies in the bhilawan shell liquid carried out with the ether extracted material by Pillay and Siddiqui² show that it mainly consists of a

catechol derivative which they named bhilawanol. Exhaustive investigations established its constitution as 1:2 di-hydroxy benzene with a C₁₅H₂₇ side chain in position 3, and led to the conclusion that it was closely related to urishiol³, the vesicant principle of the Japanese lacquer, *ki-urushi*, varying from it only in the number and position of an aggregate of two double bonds in the side chain. Apart from bhilawanol, the presence of a higher molecular phenolic product (molecular weight, about 1,000) was also indicated. On the basis of these findings it was suggested by Pillay and Siddiqui (*loc. cit.*) that the shell liquid might form a valuable addition to the list of natural products used in the lacquer industry.

As a result of investigations carried out since 1940 under the auspices of the Board of Scientific and Industrial Research, a number of processes have been worked out for converting the bhilawan shell liquid into non-vesicating, semi-solid to solid products, which can be utilized in the manufacture of lacquers, varnishes, enamels, insulating materials and moulding plastics⁴. The shell liquid has also been employed for the regeneration of rubber waste for the production of hard (ebonite substitute), semi-hard and soft rubber goods⁵. Cracking of the shell liquid and subsequent fractionation of the cracked product has led to the isolation of catechol, a series of unsaturated hydrocarbons and lower phenols. While studies in the chemical constitution of these products are in progress, it has been shown that the phenolic components can be employed for the manufacture of syntans, which serve as valuable adjuncts to vegetable tannage.

As bhilawan shell liquid was not a commercial commodity, a special plant was designed and constructed for its large-scale production. It consisted of a series of iron retorts of a semi-elliptical cross section 5'-6' long, 2'-2.5' wide and 18" high, set at an inclination of 1" per running foot, and placed in fire-brick chambers, provided with dampers and connected by flues to the fire-place and chimney. The furnace design ensured a temperature control within $\pm 25^\circ$ C. from 200° to 500° C. In this process of heat expulsion, which is being employed on a commercial scale, the shell liquid obtained does not yield any bhilawanol and consists entirely of a semi-polymerized product. While this material is suited for the production of enamels, lacquers, varnishes and certain other plastic



1. Semi-hard and soft rubber from rubber waste reclaimed with bhilawan. 2. Fbonite substitute from rubber-waste reclaimed with bhilawan.

compositions, it cannot be employed for a variety of other uses where it is essential to have the bhilawanol molecule intact. An improved process evolved by Siddiqui and Azhar Ali Khan⁶ for the expulsion of the shell liquid by exposing the nuts to superheated steam has resulted in the production of a shell liquid comparable to the solvent extracted material. In this process, the nuts are exposed to superheated steam at temperatures ranging from 180°-230° C. in closed metal retorts, provided with an inlet for steam and an outlet for the expelled shell liquid.

Of the various compositions which have been evolved from the bhilawan shell liquid

(see chart, p. 735), the following have already reached the utilization stage:—

Bhilawan Stoving Enamel.—

The bhilawan stoving enamel which has been under commercial production since 1942 at the *Jay Engineering Works, Ltd., Calcutta*, can be sprayed or applied with a brush or by dipping. It gives exceptionally glossy, hard, elastic and tenacious films without the addition of any pigment or admixture of a drying oil or resin, on stoving at 140°-150° C. for two to three hours. At about 200° C., the temperature usually required for stoving the enamels available on the market, the stoving time can be reduced to about 15 min. In thin films the enamel gives a bronze, iridescent effect to metal surfaces. The weathering tests have shown that the enamel is very resistant to weather conditions. Hard baked films of the enamel are, moreover, unaffected by boiling water, the usual organic solvents, strong acids and 20 per cent. alkali. They also stand temperatures between 300°-350° C. and are fairly resistant to free flame. The cost of production inclusive of overhead charges during the war was Rs. 4 to Rs. 5 per gallon of finished enamel.

Modified Enamels.—A whole range of stoving enamels has been obtained by modifying the bhilawan resin with certain vegetable oils, bitumen, asphalt and pitch, using bhilawan shell liquid in small proportions. Of particular interest among them is a linseed oil modified enamel which gives transparent films of a yellow to brownish-red colour. The oil and bitumen modified enamels are comparable to the standard bhilawan stoving enamel in respect of hardness, gloss, elasticity and resistance towards heat, chemical reagents and solvents. The asphalt and pitch modified enamels are slightly inferior in elasticity. The cost works out at Rs. 4 to Rs. 5 per gallon in the case of oil modified

enamel and Rs. 2 to Rs. 4 in the case of pitch, asphalt and bitumen modified enamels.

Air-drying Varnishes.—Air-drying varnishes in various shades and colours have been produced from resins obtained from co-polymerization of bhilawan shell liquid with easily available indigenous raw materials. The air-dried films are very glossy and are comparable in hardness, elasticity and drying time with other oil varnishes. One of the compositions has been found suitable as an above ground anti-termite varnish. On the basis of existing prices of raw materials, the cost per gallon has worked out to be about Rs. 6.

Bhilawan Injection and Compression Moulding Powders.—Various compositions have been evolved for moulding powders with resins produced from bhilawan shell liquid as binders. The moulded articles are comparable to bakelite in respect of heat and electrical insulation, water absorption and machinability. The following table gives the characteristics of the moulding powders :—

Compression Moulding Powders :

Moulding quality	Thermoplastic
Moulding temperature ..	130°-140° C.
Moulding pressure	1,000-1,200 lbs./sq. in.
Specific gravity	1.5
Tensile strength	1,600-2,000 lbs./sq. in.
Breakdown voltage	750-1,000 volts per mil.
Water absorption in 24 hrs.	0.5 per cent.
Action of weak alkalis and weak acids	Slight
Weathering tests (exposed in open for two years in Delhi)—only surface corrosion.	

Injection Moulding Powders :

Flow	Good
Moulding temperature ..	140° C.
Moulding pressure	6 tons/sq. in.
Finish	Good



3. Bhilawan enamel for decoration work and as substitute for spelter (railway buffer plate). 4. Bhilawan plastics.

A thermosetting composition suitable for compression moulding has been evolved recently. The cost of production inclusive of overheads has been worked out to be 4-5 annas per lb.

Ebonite Substitute.—Hard rubber produced from whole tyre waste by regenerating it with bhilawan shell liquid compares favourably with imported ebonite as will be seen from the results of test below.—

Moulding qualities ..	Semi-thermo setting
Moulding temperature ..	150° C.
Final oven cure temperature	80°-100° C.
Moulding pressure	1,000-1,500 lbs./sq. in.
Specific gravity	1.5
Tensile strength	4,000 lbs./sq. in.
Compressive strength ..	6,000 lbs./sq. in.

INDUSTRIAL UTILIZATION OF BHILAWAN

BHILAWAN NUT							
(Heat expulsion)		(Solvent extraction)		(Expulsion with steam)			
Bhilawan shell liquid	Volatile by-products	Char	Bhilawan shell liquid	Bhilawan shell liquid	Semicarpol	Char	
Black stoving enamel	Catechol		Bhilawanol	(Cracking)			
Oil modified enamels	Hydrocarbons						
Light coloured enamels and varnishes	Phenols						
Insulating enamels and varnishes			Hydro-bhilawanol	Catechol	Hydrocarbons	Phenols	
Anti-white ant varnish							(sulpho-nation)
Waterproofing compositions			Pharmaceutical preparations under investigation				
Injection moulding powders							
Compression moulding powders							
Regeneration of rubber waste (Ebonite substitute, semi-hard and soft rubber)							Syntans
Syntans							
Adhesives							
Marking ink							
Anti-oxidants							
(Stabilizer for pyrethrins)							
Chrome leather dye							
Impact strength	0.5						
Beam strength	12,000 lbs./sq. in.						
Water absorption	0.03 per cent.						
Electric surface resistivity under air dry conditions at 30° C.	1.1 x 10 ¹²						
Breakdown voltage	1,840 volts per mil.						
Di-electric constant	6.7						
Machining qualities	Excellent						
Free sulphur content	1.25 per cent.						

Availability of Bhilawan Nuts

The bhilawan nut is included among the minor forest products and is collected along with myrobalan in the Central and Southern Indian forest areas. No separate organizations exist for its collection and, therefore, statistics regarding its density of growth and amount of produce could not be gathered from Forest Department authorities. Inquiries from the Forest Departments of two Southern Provinces have shown that only 3,000 mds. are collected there annually. This figure obviously refers only to the recorded collections, carried out at present to meet the limited demand for bhilawan in the indigenous practice of medicine and among washermen for marking linen. A correct estimate of the enormous quantities, which are wasted for want of demand and consequent lack of organized collection, can be possible only when a proper survey is

carried out by parties interested in the commercial exploitation of the new industrial uses of bhilawan. In the meanwhile, it may be stated on the basis of reports from C.P. and Madras, as well as a proving survey of certain areas in the Hyderabad State, that with a regular drive for its collection, bhilawan may be made available in quantities approaching those of its sister plant cashew-nut (*Anacardium occidentale*), which grows under similar conditions and of which nearly 50,000 tons are annually collected for the cashew kernel and shell liquid industries of Southern India.

References

- 1 R. N. Chopra, *Indigenous drugs of India*; Dymock, Warden and Hooper, *Pharmacographia Indica*, 1891, Vol. I.
- 2 Pillay and Siddiqui, *J. Ind. Chem. Soc.*, 1931, 8, 517.
- 3 Majima, *Ber.*, 1913, 46, 4080.
- 4 Siddiqui, *J. Sci. Ind. Res.*, 1942, 1, 19.
- 5 *Indian Patent* No. 28002 (1942); No. 28003 (1942); No. 28004 (1942); No. 28005 (1942); No. 29051 (1943); No. 29938 (1943).
- 6 *Indian Patent* No. 29155 (1943).
- 7 *Indian Patent* No. 32237 (1945); *Indian Patent* "Improved apparatus for expulsion of bhilawan shell liquid." (Dr. S. Siddiqui and Azhar Ali Khan) pending.

6. CASHEW SHELL LIQUID

By S. SIDDIQUI

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THE cashew-nut tree (*Anacardium occidentale*; Hindi, *Kaju*), which belongs to the same natural order, *anacardiaceæ*, as Bhilawan (*Semecarpus anacardium*) is a native of Brazil and was introduced into India by the Portuguese in the sixteenth century. It has taken kindly to the Indian soil and grown in abundance in the coastal regions of the Bombay and Madras Provinces, upto a height of 2,000' to 3,000', in gravelly areas unsuited for cultivation of other crops.

The cashew kernel trade was till recently the exclusive concern of cottage industries on the western coast of Southern India. Due to the popularity of the cashew kernel as an article of diet in Western countries, principally in the U.S.A., a large number of factories (about 100) have sprung up during the last two decades to meet the growing demand and about 100,000 people are employed in these factories for roasting the nuts. Available statistics show that nearly 60,000 tons of the nuts are produced in India and 10 to 20 thousand tons are imported from East Africa. An idea of the phenomenal growth of the industry can be had from the pre-war export figures given below:

Kernel

	Quantity Tons	Price \$
1938-39	11,600	3,507,734
1939-40	13,500	4,036,325

Shell liquid

	Quantity Tons	Price Rs.
1938-39	337	1,71,318
1939-40	1,205	4,90,109
1940-41	1,239	5,40,758

The shell liquid constitutes nearly 20 per cent. of the whole nut, but is obtained in much smaller yields as a by-product of the nut processing. As the material could not find adequate use in this country, almost the whole of it has been exported to America, where it has been established as a starting material of exceptional value for the plastics industry, mainly as a result of researches carried out on its industrial application by Harvey and collaborators since 1928¹.

Extraction of the Shell Liquid

An improved method of production is based on the expulsion of shell liquid from the nuts, by heating them in an oil bath at about 270-380° F. According to a patent of W. Jefferies and Pierce Leslie & Co., Ltd., the nuts are passed through oil, obtained from similar nuts, in single layers, on an endless conveyer belt. The temperature of the oil is maintained at about 370-380° F. and the time of travel is about 15' in 80-90 secs. Only about 50 per cent. of the oil is extracted by this process but manual decortication of the nut becomes easy after the processing and the quality of the kernel is not adversely affected by it. After the removal of the kernel, a further quantity of the shell liquid is recovered from the shells by steam distillation. Recently, a process for the expulsion of cashew shell liquid from the nuts and the shell has been patented by Siddiqui and Azharalikhan². In this process the nuts or shells are exposed to superheated steam at a temperature of about 360° F. in a closed retort provided with an inlet for superheated steam and an outlet for the expelled liquid and waste steam. About 95 per cent. of the shell liquid is expelled by this process.

Chemistry of Cashew Shell Liquid

The resinous pericarp juice of the cashew nut was first investigated in 1847 by Stadler³ who isolated an acid from it, viz., anacardic acid, forming 90 per cent. of the juice and a non-acidic substance, cardol, which strongly blisters the skin, in a yield of about 10 per cent. Later Ruhemann and Skinner⁴ assigned to the acid its correct formula, $C_{22}H_{32}O_3$ and considered it a hydroxy carboxylic acid. More recently, a detailed study of anacardic acid by Smit⁵ led to its formulation as penta-deca-dienyl salicylic acid. Later Pillay⁶ made a fairly exhaustive study of the problem, and on the basis of his investigations on its reduction, oxidation, decarboxylation and fission products, he suggested for it the structure of a salicylic acid derivative with a pentadecadienyl chain in the *ortho* position. Indirect evidence has, however, been subsequently brought by Gokhale, Patel and Shah⁷, through the synthesis of *ortho* and *para* pentadecyl phenol, and its comparison with tetra-hydro anacardol to show that the pentadeca dienyl side chain in anacardic acid must be in *ortho* position to the carboxyl group.

Industrial Applications

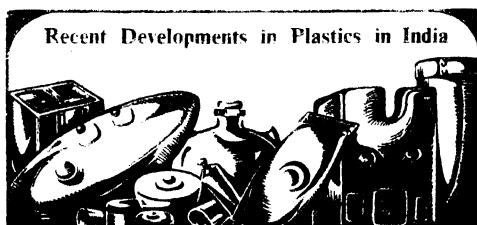
Harvey and collaborators have worked out a number of processes for the conversion of the cashew shell liquid into solid or semi-solid resins suitable as starting materials in the varnish and plastics industry. These methods which are covered by a large number of patents dating from 1928, are principally based on the use of concentrated, mineral acids, methyl sulphate, formaldehyde hexamethylene tetramine and a number of inorganic salts, as chemical reactants or catalysts. The plastic materials obtained by the various processes are being employed in America, alone or in combination with other resins in the preparation of insulating varnishes, typewriter rolls, oil and acid-proof acid setting cements, industrial floor tiles and automobile brake linings and also as a substitute for rubber for certain requirements, alone or in combination with synthetic rubber.

With the object of utilizing the cashew shell liquid for the benefit of the Indian

industry, investigations were taken up in the laboratories of the Director, Scientific and Industrial Research. As a result of this work a process for the conversion of cashew shell liquid in combination with varying proportions of bhilawan shell liquid into a semi-solid to solid resin has been worked out and patented by Siddiqui and Azharalikhan⁸. The resins obtained through this process have been utilized for the production of enamels, varnishes, water-proofing compositions and moulding powders.

References

- ¹ Harvey and Capalan: *Ind. Eng. Chem.*, 1940, **32**, 1306.
- ² Siddiqui and Azharalikhan, *Indian Patent* No. 28424 (1942).
- ³ Staedeler: *Annalen*, 1847, **63**, 137.
- ⁴ Ruhemann and Skinner, *J.C.S.*, 1887, T 663.
- ⁵ Smit; *Proc. K. Akad. Westenshappen, Amsterdam*, 1931, **34**, 165.
- ⁶ P. P. Pillay, *J. Ind. Chem. Soc.*, 1935, **12**, 226.
- ⁷ Gokhale, Pater and Shah, *Cur. Sci.*, 1940, **9**, 363.
- ⁸ Siddiqui and Azharalikhan, *Indian Patent* No. 32237 (1945).



IV—QUASI-SYNTHETIC PLASTICS

1. SHELLAC-FORMALDEHYDE-UREA MOULDING POWDERS

By M. VENUGOPALAN

(Indian Lac Research Institute, Ranchi)

SHELLAC has been generally classified as a thermoplastic resin since most of the grades of lac show little change in their plastic properties, such as flow, during the length of time the compositions are subjected to fabrication. However, when shellac or its compositions are subjected to prolonged heating they pass on to an insoluble and infusible state through a process of condensation-polymerization ultimately ending in a tough horny product. For many of the applications of shellac, prolonged heat-treatment was considered as a disadvantage

and it, therefore, became essential to shorten the time of polymerization by some chemical means.

It has been found that a large number of chemicals, like polycarboxylic acids or their anhydrides, polyamines, dicyandiamide, bi-guanidines, oxides of polyvalent metals, such as lime¹, urea², etc., accelerate the polymerization of lac under heat. Among these urea has been found to be the most powerful accelerator. The use of urea alone in shellac moulding compositions³ has, however, resulted in powders of low fluidity necessitating the use of high moulding pressures. Besides, the compositions being low in heat resistance had to be cooled before ejecting the articles from the mould. It was clear, therefore, that in order to render shellac compositions suitable for working

under the standard compression technique used for thermosetting materials, they must be so modified as not to effect any change in fluidity and the moulded articles should be capable of ejection at the temperature of the mould without distortion or blistering.

These requirements are achieved by a suitable modification of shellac beforehand by treatment first with formalin and then with urea to promote further condensation⁴. It has been found that 15 per cent. urea and 19 per cent. formaldehyde based on the weight of lac were found to give the best results.

The method of preparing the moulding composition is briefly as follows:—

Shellac and formaldehyde are at first reacted at about 120° C. for one hour. The resulting product is dissolved in rectified or methylated spirit and the requisite amount of urea added in small proportions at a time. The mixture is then refluxed for 2 hours and the product mixed with flour, pigments, lubricants and lime in suitable proportions. The mass is then kneaded in a kneader-mixer, air dried, powdered to 60 mesh and finally dried at 90° C. to remove alcohol and moisture. The powder thus obtained could be moulded at 130-140° C. under 1½-2 tons per sq. inch pressure with 2-3 minutes cure. Once-moulded articles or the rejects when recrushed could be equally well moulded at a little higher temperature at 2-2½ tons pressure per sq. inch, thereby showing characteristics of a borderline composition between thermoplastic and thermo-hardening resins.

Moulded bar specimens have the following characteristics:—

Impact strength	6.0 cm.kg. per sq. cm.
Heat stability temp. (Martens grade)	87° C.
Water absorption, 24 hrs.	1.0 per cent.

The incorporation of 5-10 per cent. phenol or 25-30 per cent. of partially polymerized cashew-nut shell liquid in the above composition has been found to improve the flow of the powders and the finish of the moulded articles. Large-scale experimental trials in the commercial bakelite moulding factories have established that these powders could be used for preparing electrical and other utility articles like switches, ceiling-roses, bottle caps, etc.

The powder can also be prepared by the dry-process by mixing between hot-rollers using little or no alcohol, thereby making the

process simpler and economical^{5,6}. Also, lac recovered from Kiri (refuse lac) by the alkali process could be substituted for costlier shellac without any appreciable effect on the ultimate quality of the powder or that of the moulded articles.

References

- 1 W. H. Gardner, *British Plastics*, 1935, 6, 524.
- 2 S. Ranganathan and R. S. Aldis, *Ind. Lac. Res. Inst., Bull. No. 14*, 1933.
- 3 S. Ranganathan, *Ind. Lac. Res. Inst., Bull. No. 30*, 1938.
- 4 M. Venugopalan and H. K. Sen, *British Plastics*, 1939, 10, 626.
- 5 M. Venugopalan, S. Ranganathan and H. K. Sen, *Ind. Lac. Res. Inst., Tech. Note No. 5*, 1940.
- 6 *Ind. Pat.* 29,329.

2. SHELLAC ESTERS

By B. S. GIDVANI

(London Shellac Research Bureau, Edinburgh)

ALTHOUGH the composition and structure of lac-resin is still not fully known, it is generally conceded that the resin consists of lactones, lactides, inter-esters and ethers of a number of polyhydroxy aliphatic and hydroaromatic acids, none of which by itself has any film-forming properties. Since all the constituent acids have not yet been identified, a formula can hardly be assigned to the lac-resin, although a number of formulæ for the hypothetical lac-molecule have been postulated^{1,2} to explain the known properties of the resin. The resin is definitely acidic (*A.V.* 60-65), has a hydroxyl value of about 280 and a molecular weight of the order of 1,000. It is generally agreed that an average molecule of the lac resin has one carboxyl and 5 hydroxyl groups, the latter being of alcoholic type. Lac-resin has, therefore, the properties of both an acid as well as an alcohol. Like an acid, it can be esterified with alcohols or it may be treated as an alcohol and its hydroxyl groups reacted with an acid. Both types of reactions have been carried out. In the first group are the alkyl esters of lac³⁻⁶ which range from viscous liquids to balsams and hard resins, depending upon the alcohol used. Thus methyl, ethyl and butyl esters of lac are viscous liquids with increasing viscosity in the stated order, while ethylene glycol ester is a balsam and the glycerol ester, a tacky solid.

These esters are soluble in common organic solvents except the aliphatic hydrocarbons and are useful for a number of applications, particularly as resin-plasticizers

for cellulose nitrate lacquers, as plasticizers for amino-aldehyde resins⁶ and as components of cements and adhesives⁸. For example, the alkyl esters of lac such as methyl, ethyl and butyl, can be successfully used for replacing the usual plasticizers and resins in the formulation of nitrocellulose lacquers. The butyl ester of bleached lac is also useful for plasticizing urea- and melamine-formaldehyde resins.

Instead of the whole lac, any fraction of lac such as hard or soft lac resins may be employed in the preparation of shellac esters. Alternatively, lac may be first hydrolyzed and the resulting lac-acids may be esterified with alcohols. Thus Kamath⁹ has described the preparation of ethylene glycol ester of hydrolyzed lac which has been found useful for imparting low-temperature flexibility to lac-films. A copolymer of this ester with added shellac gives flexible films which on a fabric base have been found to remain flexible down to -40° C. Being resistant to various hydrocarbon solvents, such coated fabrics are particularly suitable for the manufacture of flexible fuel tanks for aircrafts. Resistance to chlorinated hydrocarbon solvents can be achieved by baking.

Films from a lacquer of this copolymer have excellent adhesion on vulcanized natural and synthetic rubber and may be used for imparting hydrocarbon solvent-resistance to rubber.

The ethylene glycol ester of hydrolyzed lac has also been used in the manufacture of cements and adhesives, in particular an excellent cement to replace De Khotinsky's cement has been obtained by heating 20 parts of the ester with 80 parts of shellac at 90° - 100° C. until homogeneous. By varying the proportion of the ester and lac, cements with varying properties can be obtained. Joints bonded with these cements, after stoving, can withstand immersion in boiling water for an hour.

Esterification of Hydroxyl Groups of Lac

Shellac esters of a different type and properties are obtained when the alcoholic (the hydroxyl) groups of lac are reacted with a suitable acid. Both saturated and unsaturated acids have been used and a new range of products with quite different properties from lac have been obtained¹⁰. For example, shellac is insoluble in hydrocarbon solvents, while shellac-fatty acid esters become increasingly soluble in hydrocarbon solvents with the increasing degree of

esterification. Lac esters from lower saturated fatty acids can be used as resin-plasticizers to replace resins and plasticizers in cellulose lacquers, while those from the unsaturated acids have properties of a drying oil. For instance, films from the lac ester of oleic acid dry on prolonged exposure to atmosphere or upon stoving. With higher saturated fatty acids, wax-like materials are obtained. The lac-stearic acid ester is waxy and has been used in conjunction with paraffin wax and other materials in the preparation of polishes and waterproofing compositions.

Mixed fatty acids of linseed and other vegetable non-, semi- and drying-oils as well as resin acids have also been used for esterifying lac. The lac esters of linseed oil fatty acids are sticky balsams which have been recommended for use in linoleum compositions. Esterification of rosin with lac gives hard resins which may be incorporated in drying oils to produce oil varnishes. The reaction between lac and rosin can be modified by the presence of phenol, castor oil¹¹, or cashew nut shell oil¹² to yield interesting compositions having excellent weather resistance. Such products after suitable pigmentation can be used as outdoor paints without adding any drying oils.

When the esterification of lac with mixed fatty acids of drying oils is carried out in the presence of glycerol or other polyhydric alcohols, mixed esters and ethers are obtained, which can be used as oil varnishes^{13,16}. These oil varnishes have excellent electrical insulating properties (*B. D. V.* nearly 1,000 volts per mil.) and are particularly recommended when a hard, smooth, glossy, oil-resistant protective coating is required. The films must, however, be stoved to obtain these properties. Air-drying varnishes can be produced by judicious incorporation of metallic driers such as cobalt linoleate or naphthenate in these compositions. Further improvements in air-drying and other properties are obtained by reacting the remaining free hydroxyl groups of the lac-oil varnish composition with either added fatty acids or some suitable resin acids. These lac-oil varnishes have excellent adhesion on various types of surfaces including light metal alloys such as aluminium and magnesium alloys. Depending upon the type and quantity of the fatty acid employed, compositions with varying properties are obtained which among others may be employed in the production of coated fabrics of the "oil-silk" type.

Esterification in the Presence of Solvents

Esterification of lac with various organic and inorganic acids in the presence of solvents and non-solvents has resulted in a number of new modifications of lac, the films of which have improved adhesion, gloss, water resistance, elasticity and flexibility¹⁷. However, the types of reactions involved have not been studied and it is uncertain whether the solvent takes part in the reaction. It would appear that some esterification between the solvent (when it is of alcoholic type) and the modifying acid, and between the alcohol and lac will also occur simultaneously with that between the acid and lac. Products obtained by this type of reaction would most probably consist of mixed esters. Mixed esters produced by refluxing malic and tartaric acid with alcoholic solutions of lac have been found suitable as adhesives for bonding metal to metal, especially copper to copper and steel to steel¹⁸.

It is thus clear that lac esters have interesting properties and can be used for a number of widely differing applications. Nevertheless they have found only a limited market, mainly because of their dark colour and high cost when compared with other competitive materials giving similar performance. The high cost of the lac esters cannot be attributed to the cost of esterifying materials or the processes but is due to the high initial price of the lac itself. If shellac esters, or for the matter of that, any lac modifications obtained as a result of recent research, are not to remain only laboratory curiosities, the price of lac must be so adjusted as to make their use economically feasible.

References

- 1 W. Nagel and W. Mertens, *Ber.*, 1937, **70**, 2173.
- 2 R. Bhattacharya, *Chem. & Ind.*, 1940, **18**, 325; cf., B. S. Gidvani, *London Shellac Research Bureau, Tech. Paper*, No. 17, 1939.
- 3 F. Ulzer and R. Defris, *Diss., Bern*, 1887.
- 4 W. Nagel and M. Koernchen, *Wiss. Verof. Siemens Konz.*, 1927, **6**, 235.
- 5 W. H. Gardner, *U.S.P.* 1,910,100 (1933).
- 6 B. S. Gidvani and N. R. Kamath, *Paint Technology*, 1945, **10**, 35.
- 7 B. S. Gidvani and N. R. Kamath, *Paint Manufacture*, 1945, **15**, 93.
- 8 B. S. Gidvani, *J. Oil Col. Chem. Assoc.*, 1945, **28**, 83.
- 9 N. R. Kamath, *London Shellac Research Bureau, Bull.* No. 7, 1945.
- 10 R. Bhattacharya and B. S. Gidvani, *Ibid.*, *Tech. Paper* No. 15, 1938.
- 11 R. Bhattacharya, *J. Oil Col. Chem. Assoc.*, 1940, **23**, 145.

- 12 G. M. Ajmani, *J. Sci. & Ind. Res., India*, 1945, **3**, 354.
- 13 R. Bhattacharya, *London Shellac Research Bureau, Tech. Paper* No. 12, 1937.
- 14 R. Bhattacharya and B. S. Gidvani, *Ibid.*, *Tech. Paper* No. 14, 1938.
- 15 R. Bhattacharya and B. S. Gidvani, *Paint Technology*, 1938, **3**, 189.
- 16 R. Bhattacharya and B. S. Gidvani, *J. Soc. Chem. Ind.*, 1938, **57**, 285.
- 17 M. Venugopalan, *Curr. Sci.*, 1939, **8**, 14.
- 18 N. N. Murty, *Plastics*, 1945, **9**, 585.

3. HORN WASTE PLASTICS

By A. JOGA RAO

(Council of Scientific and Industrial Research, Delhi)

WITH nearly a third of the world's head of cattle, horns and hoofs constitute an important commercial raw material in India. Barring the faultless and large pieces of horn which are employed for making a variety of utility and fancy articles by local artisans, the raspings and rejects have found no use except for the production of fire-extinguishing foams or of fertilizer. Numerous investigations have been carried out with a view to taking advantage of the toughness, strength and other valuable qualities of horn in the manufacture of plastics. A majority of the investigations fall under the following heads:—

- (a) Preliminary softening in the presence of weak alkaline solutions, strong acids or other chemicals, and pressing in closed moulds under heat and pressure,
- (b) maintaining a critical moisture-content in the comminuted waste and pressing, adding substances like glycerine, salicylic acid, blood, rosin, milk, shellac, etc., and
- (c) using raw or calcined horn waste as modifiers for phenol-aldehyde or urea-aldehyde resins.

None of the processes described in the literature or covered by patents appears to have been commercially exploited.

A large number of experiments based on literature references was carried out in the Laboratories of the Council of Scientific and Industrial Research, and it was found that practically all the moulding powders so made were unsuited to the high-speed mass production technique of the modern plastics industry. Only processes involving the use of horn and hoof waste in conjunction with phenol-aldehyde or urea-aldehyde resins were found to hold promise. In the course of this

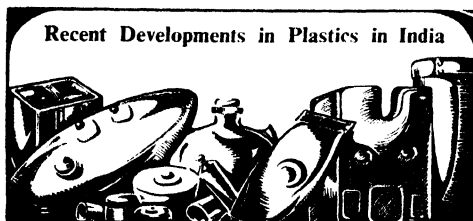
work a new moulding powder (designated SHP-71) was developed based entirely on indigenous materials. Shellac and keratin-degradation products obtained by controlled hydrolysis of horn waste together with suitable fillers are the chief ingredients of the moulding powder. Its moulding characteristics are similar to those of bakelite-type powders, except that a slight cooling of the moulds by about 20° C. is necessary before ejection. Properties of mouldings obtained are fairly satisfactory except in the matter of resistance to alkalis. Detailed data regarding the mechanical strength, electrical insulation, water-absorption, etc., are given in Table I. The greater scope for procurement of urea and formaldehyde at present, and the satisfactory nature of the properties of the moulded articles examined, indicate a good future for horn-urea-aldehyde moulding powder whose characteristics are also given in Table I.

TABLE I.

	SHP-71 powder	Horn-urea-aldehyde powder
Moulding qualities and flow	Good	Good
Moulding temperature, °C.	120-130	140-160
Moulding pressure, tons/sq. in.	1-1½	1-1½
Packing ratio (ungranulated powder)	1:3.5	..
Mould shrinkage, per inch	0.0028-0.0042	..
Tensile strength, lbs./sq. in.	2400-2800	3250-5800
Impact strength, foot lbs./sq. in. (at right angles to the direction of moulding)	2.5-3.5	2.2-2.4
Water absorption, percentage by weight in 24 hours	7.0 (3.0-3.5)*	4.0-5.3
Water resistance	Satisfactory	Good
Dielectric constant (1,000 C.P.S.)	5.8	..
Power factor (at 1,000 C.P.S.)	0.048	..
Hardness, 12.7 mm. ball, 100 kg. load for 15 secs. (Brinell number)	16.7	..
Effect of weak acids (24 hrs.)	Resistant	Resistant
Effect of weak alkaline solutions	Affected	Resistant
Effect of soap solution	Fairly resistant	Resistant
Effect of low pressure steam	Resistant	Resistant

*The figure within the brackets is for hot-roll mixed powder; other figures are for the wet-mixed powder.

The process for SHP-71 has been patented and assigned for commercial exploitation.



V—PROCESS DEVELOPMENT

1. DRAWN LAMINATED MOULDINGS

By LAL C. VERMAN

(Council of Scientific and Industrial Research, Delhi)

DRAWN laminated moulding process represents a natural outcome of the numerous developments related to container manufacture stimulated by the war-time shortage of sheet metal¹, which affected almost all the belligerent countries. Plane laminated sheets and boards from plastics-impregnated fabrics and paper had been well recognized for the inherent advantages in respect of mechanical strength due to co-ordinated reinforcement, but little had been done by way of shaping these laminated

products into intricate shapes, though numerous types of utility articles had been produced by punching, drilling, turning and other machining operations on the finished sheet. Laminated tubing had been utilized in various applications. One of the attempts at producing intricate shapes in laminated goods resulted in the production of corrugated boards². For the production of more intricate shaped mouldings or containers only the powder moulding technique was available. Early attempts at container manufacture from laminated stock required a number of operations by way of shaping the prepressed sheet material leaving the edges unpressed, followed by pressing the joints³.

In view of the fact that metal sheet drawing and pressing operations had been well developed for the production of intricate



Fig. 1.—Solid dentifrice container in two laminations of jute cloth with pigment filled thermoplastic impregnating resin.

Fig. 2.—Ash tray moulding with two stripped multi-coloured cotton cloth lamination on the outside and one jute cloth lamination inside, in thermosetting type of resin.

Fig. 3.—Powder box moulding with multi-coloured checkered cotton cloth and jute core combination.

machine parts and containers, etc., it was thought possible to combine this technique with the well-known processes for the plastic powder compression mouldings and laminated sheet production, with the object of producing intricate shaped mouldings and containers directly from unpressed laminated stock. The successful development of this attempt is illustrated by some of the articles shown in Figs. 1 to 6. While all the possibilities of this process have not been so far fully realized in practice, it has been considered desirable to cover it by Indian as well as foreign patents⁴.

Obvious advantages of this process may be briefly summarized as:

- (1) Simplicity of operation characterized by a single pressing operation as in ordinary plastic powder compression mouldings.
- (2) Comparatively higher strength and lighter weight compared to powder compression mouldings and metal sheet products.
- (3) Possibility of utilizing decorative materials such as dyed, printed and multi-coloured cotton fabrics for exterior laminations and relatively cheaper materials such as jute cloth for interior laminations.
- (4) Low cost of production resulting from (i) simplicity of operation and (ii) savings in materials due to (a) lighter weight, and (b) cheaper materials for interior cores.

The highly specialized procedure developed for the design and production of mould equipment for this process has been briefly referred to in another article of this symposium. In certain deep drawing operations, a pilot plunger together with a locking device for suitably guiding the laminated stock into

the moulds has been found necessary⁵. One associated development involves the production of raised letterings, labels and trade mark devices on the moulded articles in distinct colourings differing from the general background, by the use of dry pigments and colours introduced in the same pressing operation⁶. For cigarette cases and articles of similar nature a new type of elastic rubber band hinge mechanism combining the effect of a self-closing spring has been developed⁷.

Experience has shown that the process is applicable to both thermoplastic as well as thermo-setting types of resins.

Further possibilities, particularly in the production of luxury goods and electrical equipment, are being investigated. But one of the most promising fields appears to be the manufacture of motor car body panels, in which lightness, strength, finish and attractive appearance are important considerations, all of which are special features of this process. Requirements of extra heavy press and mould equipment, however, may considerably delay this development.

References

¹ Anon, *J. Sci. Ind. Res.*, 1944, 2, 109.

² Bhatnagar, S. S., Khan, C. A. R. and Verman, L. C., *Ind. Pat.* No. 28,281 (1941).

³ Bhatnagar, S. S., Prem Prakash and Verman, L. C., *Ind. Pat.* No. 28,421 (1941).

⁴ Bhatnagar, S. S., Khan, C. A. R. and Verman, L. C., *Ind. Pat.* No. 30,680 (1945) *Brit. Pat. Appl.* No. 8,340/45 (1945) pending; *U.S.A. Pat. Appl.* No. 577,112 (1945) pending; *Indian States Patents*, 1945, pending.

⁵ Sikka, B. N., Singh, G. and Verman, L. C., *Ind. Pat.*, No. 32,824, (1945) pending.

⁶ Sikka, B. N., Singh, G. and Verman, L. C., *Ind. Pat.*, No. 32,823 (1945), pending.

⁷ Verman, L. C. and Singh, G., *Ind. Pat.* No. 34,040 (1946), pending.

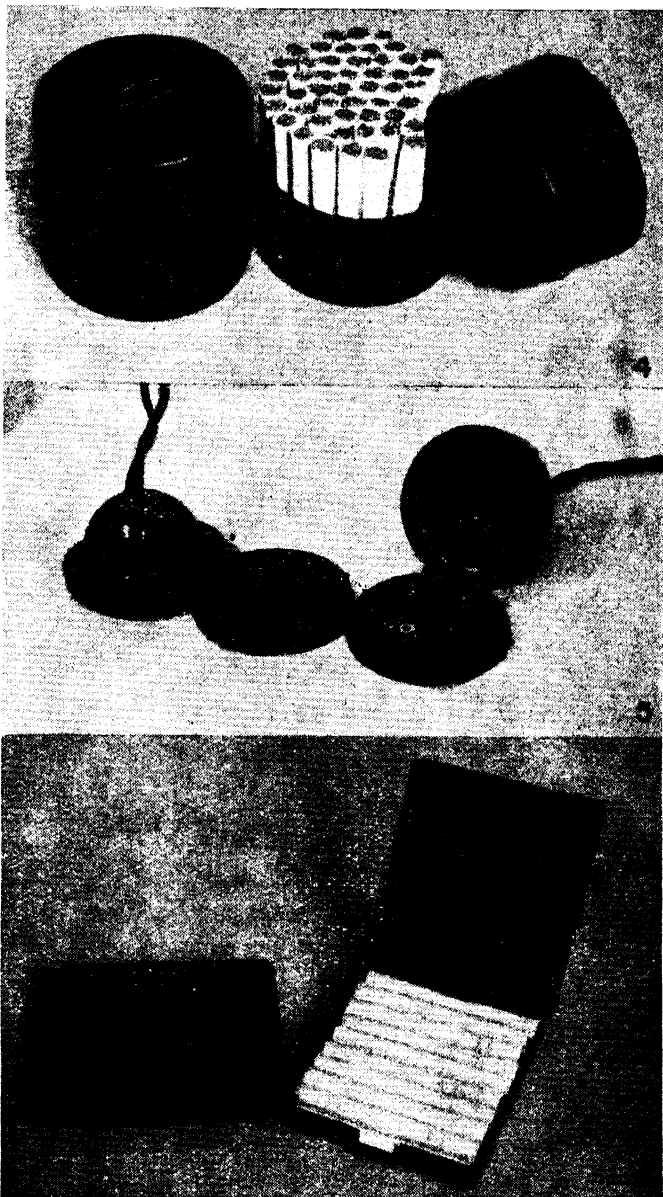


Fig. 4.—50-cigarette deep-drawn container in two-ply pigment filled jute cloth with trade mark device in gold against green background.

Fig. 5.—Electrical ceiling-rose complete with terminals in pigmented thermo-setting resin; note the threads and counter-sunk feet for screws.

Fig. 6.—20-cigarette case with rubber spring hinge in cotton cloth-jute combination.

2. LAMINATED PLASTIC CONTAINERS WITHOUT THE USE OF HYDRAULIC PRESSES

By LAL C. VERMAN

(Council of Scientific and Industrial Research,
Delhi)

EARLY developments of laminated container manufacture, stimulated by the shortage of sheet metal, led to processes requiring heavy press and mould equipment¹ which became more and more expensive and unwieldy as the size of the container increased. With a view to avoid expense and meet the war-time scarcity of such heavy machinery, it was considered desirable to explore the possibilities of making fairly large size containers without the use of heavy hydraulic presses.

One of the methods adopted was the development of a well plasticized resin solution which could be applied by paint brush to the fabric and which would easily penetrate its structure. A 50:50 mixture of dewaxed shellac and depolymerized shellac (D.P.L.) in conjunction with urea as hardening agent was found quite suitable for this purpose. Several layers of treated fabric forming the main walls of the container were pressed with hand under a hot flat iron on wooden formers and shaped suitably to form the body of the container, the material resembling hydraulically pressed laminated board. End pieces of the container were similarly shaped to form suitable flanges, which could be sealed internally to the main body of the container. Several four-gallon petrol containers in two-ply cotton canvas, stiffened by bamboo strips were thus prepared, one such being shown in Fig. 1. Originally, it was thought that the container bodies and ends could be sewn up on machines and then the joints sealed with cement, but finally a technique was developed in which machine sewing was entirely dispensed with and joints of requisite strength produced by the use of resin cement alone.

Mechanical strength of such containers, admittedly, does not correspond to those made by the use of hydraulic pressure, but it is found to be sufficient for a great many applications as, for example, the four-gallon containers referred to above could be readily used for transporting fuel in the same manner as tinned iron containers built for a similar purpose.

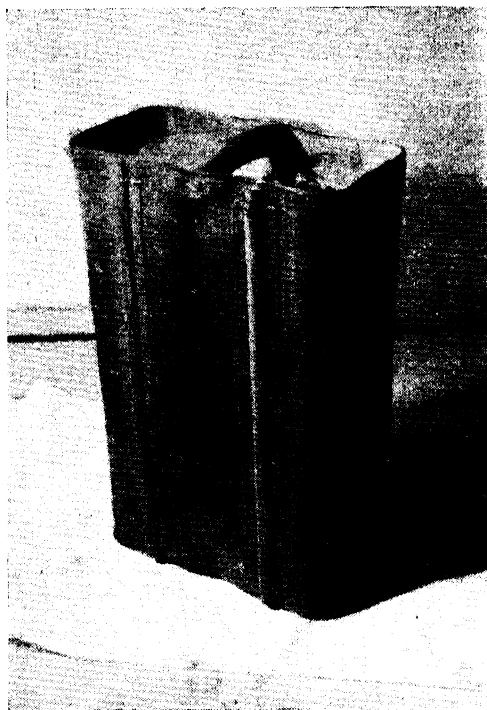


Fig. 1.—4-gallon petrol container made of 2 laminations of impregnated cotton canvas, hand pressed and stiffened with bamboo strips with screwed metal stopper.

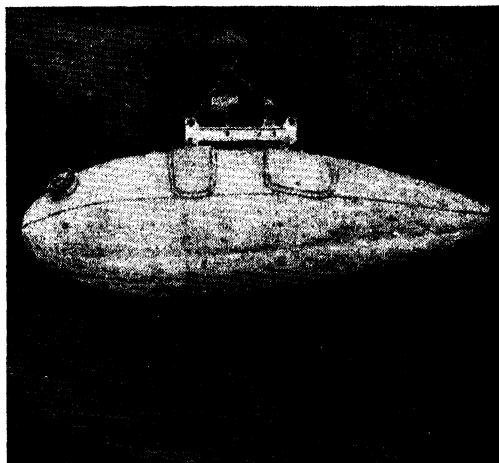


Fig. 2.—75-gallon Jettison tank in single layer of canvas, with inside stiffening walls, impregnated and stiffened with plastic composition under 2 lbs. per sq. in. pneumatic pressure.

Another shellac composition was developed for use with large jettison tanks (75-gallon capacity) such as those used by the American Army Air Force. Envelopes of these tanks are machine sewn in single-ply canvas and transported to the front in rolled up form. A powdered resin composition is also supplied, which is simply to be dispersed in water and the solution introduced into the outstretched canvas tanks or bags. The tank is then blown up with air with the aid of a hand or foot operated bicycle or tyre pump to a pressure of about 2 lbs. per square inch. When under pneumatic pressure, the tank is rolled about to spread the solution which tends to ooze out through the pores of the canvas, thus impregnating it thoroughly. The oozing solution is smeared on the outside surface and soon begins to set dry forming an impervious film. In the course of a few hours the whole tank dries up and becomes stiff enough for being put into service.

Shellac composition required for such an application had to satisfy various stringent requirements, such as, for example:

- (1) to readily disperse in tap water,
- (2) to dry rapidly,
- (3) to form an impervious and strong film, and
- (4) the film formed to be proof against petrol as well as rain water.

These and other requirements were met with by a composition containing shellac, casein, portland cement, borax, sodium carbonate and urea. Fig. 2 shows one such jettison tank impregnated with the resin mixture described. In view of the fact that tanks of this type are to be used only once in service, the strength requirements are not so rigid. So long as the tank can hold its shape under full load of fuel, it is considered satisfactory.

Reference

1 Bhatnagar, S. S., Prem Prakash and Verman, L. C., *Ind. Pat.* No. 28,427 (1941); Anon., *J. Sci. Ind. Res.*, 1944, 2, 109.

3. JUTLAC—A NEW FABRIC-SHELLAC LAMINATE

By R. W. ALDIS

(Angelo Bros., Ltd., Calcutta)

SINCE the outbreak of war in 1939, patents have been taken out in India relating to the manufacture of laminated sheets from jute fabric using shellac resin and

shellac compositions as the bonding medium. Considerable publicity has been given to these jute fabric laminates, of which there has been a large production by *Messrs. Angelo Bros., Ltd.*, and a number of Calcutta jute mills. The product manufactured by these concerns is popularly known as *Jutlac*. The patents granted to Sir S. S. Bhatnagar and others¹ and held by the Government of India, and those held in the name of *Angelo Bros., Ltd.*, and *Indian Jute Mills Association Research Institute*² are based on two entirely different principles. The essential basis of the claims made in the former, is the impregnation of jute fabric with an alcoholic or aqueous solution of shellac, removal of the solvent by drying and moulding under heat and pressure. This method is standard practice for fabric and paper laminates produced by hydraulic pressure. The principles and methods involved in the patents held by *Angelo Bros., TIJMARI*, are entirely different, and were developed expressly to meet a war emergency situation in the development of fabric laminates where large-scale production of a suitable article could be ensured in a minimum of time. The basis of the claims are dependent on the formation of sheets of jute fabric coated with a layer of shellac and the subsequent formation of cylinders or flat sheets by laminating these single-coated sheets in a pressure moulding system. In the manufacture of cylinders, a sheet of jute fabric coated with shellac is rolled on to a mandrel which is then pressed between rolls geared to rotate in the same direction, one roll being hot and the other cold. In the case of flat sheets, two or more sheets of coated fabric are pressed together between a series of hot and cold rolls and drawn out under a suitable tension.

The chief advantages claimed for the molten shellac process are, firstly, that the necessity and consequently the cost of solvents and equipment for their recovery are eliminated. Secondly, the use of hydraulic presses of high capital cost has been replaced by the utilization of cheaper and more readily obtainable pressure rolls. Thirdly, the inherent strength of the laminated material produced is greater because of its resiliency without brittleness, and fourthly a continuous process was made possible which yields a very high rate of production. The output capacity of the plant at *Angelo Brothers*, when operating three 24" machines

was 25,000 sq. ft. of three-ply flat sheets per day. During the year ending 30th September 1945, the output of all plants engaged in the manufacture of jutlac was in the neighbourhood of 13 million sq. ft. of three-ply material.

The uses to which *Jutlac* products have been put are numerous and varied, examples being in the manufacture of tea chests, supply dropping equipment and numerous other military containers, racking, panelling and boarding, sliver can, cop boxes, grease drums, cigarette boxes and miscellaneous containers generally.

References

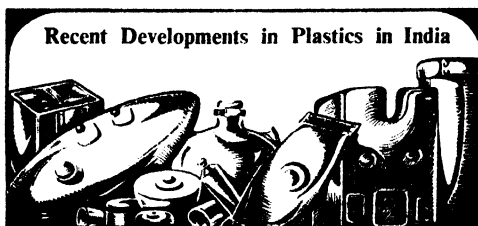
¹ *Ind. Pat.* No. 28,277 (1941); No. 28,821 (1941); No. 28,427 (1941).

² *Ind. Pat.* No. 28,934 (1942); No. 29,370 (1943).

[It must be pointed out that Sir S. S. Bhatnagar and his colleagues had produced jute laminates using molten lac long before the *Indian Jute Mills Association Research Institute* and *Messrs. Angelo Brothers*. The work was carried out in the University Chemical Laboratories, Lahore, as early as 1926, and its commercial possibilities, particularly for constructional purposes and for the production of containers,

attracted wide attention. No patents were taken, as it was not the policy of the Punjab University to take out patents, and further, better products could be produced by impregnation methods. Detailed investigations on the methods of spreading resin on fabrics and processing them, were subsequently undertaken in the Laboratories of the *Board of Scientific and Industrial Research* at Calcutta, in 1940 and subsequent years. That neither solvents nor hydraulic presses were indispensable for the production of containers is shown by the work on petrol containers and jettison tanks, carried out in the Board Laboratories and described by Dr. Lal C. Verman in the preceding article. It may be mentioned here that it is not the policy of the *Council of Scientific and Industrial Research* to oppose patents, unless it be that such opposition is necessary in the interests of industrial development. The D.S.I.R. has, on many occasions, complimented the *I.J.M.A.R.I.* and *Messrs. Angelo Bros.* for the development work on laminated sheets employing jute fabric and shellac resin, but there can be no doubt whatever that the possibilities of making laminated products particularly containers using jute and lac was first suggested by Sir S. S. Bhatnagar and worked out by him and his colleagues.

For a full account of the development of resinated fabric laminates, reference is invited to an article appearing in *Current Science* (October 1945, p. 251) —Ed.]



VI—PLANT AND EQUIPMENT

1. MANUFACTURE OF HYDRAULIC PRESSES IN INDIA

By JEEVANLAL GAUBA

(*Simplex Manufacturing Co., Ltd., Delhi*)

IN view of the difficulty of obtaining equipment from abroad, the *Council of Scientific and Industrial Research* made efforts to induce firms in India to manufacture hydraulic presses for the plastics industry.

In response to these requests, *P. L. Berry & Co., Calcutta*, and *Simplex Manufacturing Co., Ltd., Delhi*, manufactured a press each for the *Council*, and it is understood that a number of similar presses have been supplied to some universities and industrial concerns.

These machines are four-pillar type, 50-ton capacity presses, (Fig. 1), and consist of:—

- (1) Hand wheel and screw for adjusting the opening between the heating platens, the screw bearing in the top crosshead;
- (2) two moving slides, the upper of which is fixed to the adjusting screw, the lower moving up and down with the ram, which has a stroke of 7";
- (3) two or more heating platens, 16" x 14", suitable for both steam and gas heating;
- (4) A hand-operated hydraulic unit, the maximum working pressure being 2.5 tons per sq. in.;
- (5) Bottom crosshead; and
- (6) Base.

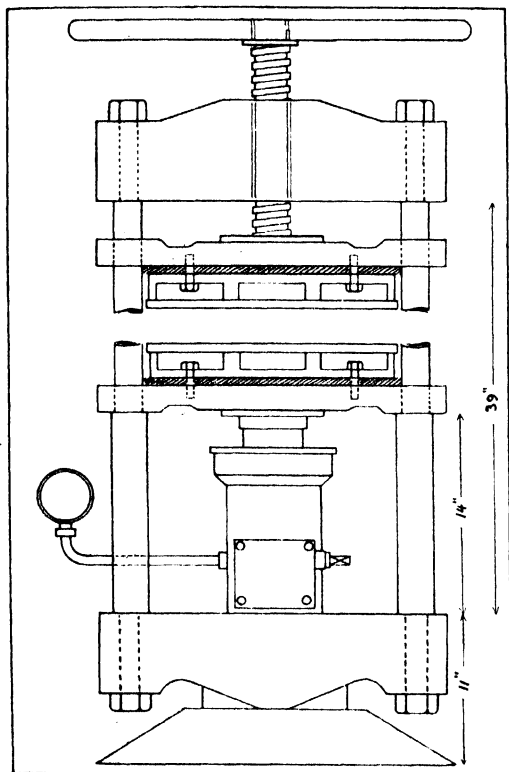


Fig. 1. Hydraulic Press.

The presses are essentially laboratory or experimental type presses. The hydraulic unit is hand-operated. As far as is known, no presses with power units have yet been manufactured in India for the plastics industry, though *Jessop & Co., Ltd., Calcutta*, have manufactured large forging power presses, and *Simpson & Co., Ltd., Madras*, manufacture both power and manually operated hydraulic presses for garages.

With the termination of the war, manufacturers in India of hydraulic presses should devote their earnest attention to developing a complete line of equipment, such as pre-forming and tableting machines, accumulators, pumps, multiple way valves and presses for the plastics industry. A 100-ton capacity press at a working pressure of 1 ton per sq. in., a platen area of 16" x 16" and 8" stroke would, it is suggested, be a very suitable general purpose press. The pumps should be of the two-stage type and should be capable of closing the press and exerting the full pressure in about 15-20 seconds.

2. DESIGN AND MANUFACTURE OF MOULD EQUIPMENT

By GURBUX SINGH

(Council of Scientific and Industrial Research, Delhi)

PROPER mould designing for fabrication of plastic materials depends on many factors. The designer should have a working knowledge of the moulding materials and their behaviour in the moulding process to enable him to decide upon the type of mould particularly adapted for the material in hand. He should be fully acquainted with mould steels¹, their heat treatment and production methods. The machines and tools required for mould manufacture include:—

(1) *General Purpose Machine Tools*, such as lathes, milling machines, shapers, planers, drilling machines, power saws and grinders, (2) *Special Tools* include duplicators or pento-graph milling machines, hobbing equipment and polishing machinery, and (3) *Auxiliary Tools* such as filing machines, hand grinders, tool grinders, hand files, abrasive stones, etc.

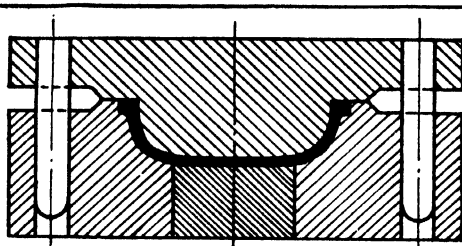
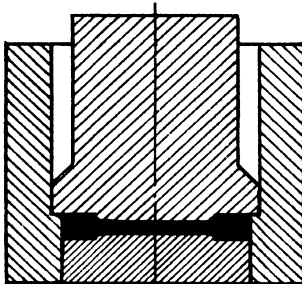
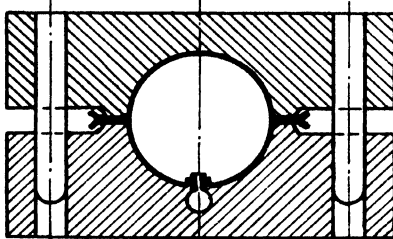
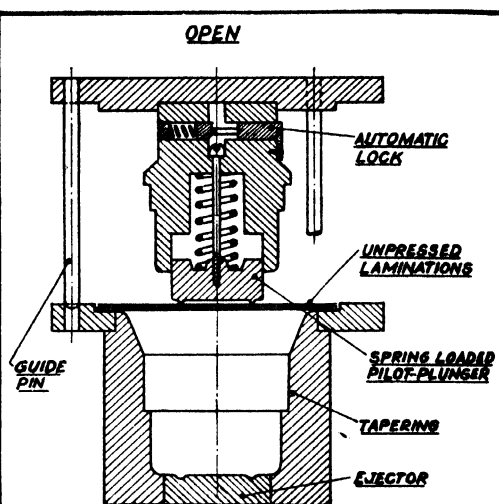
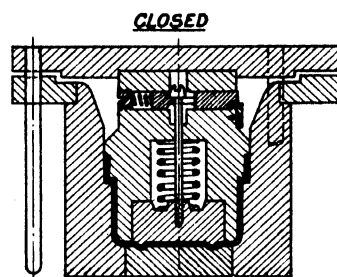
Thermosetting plastics such as phenolics and ureas, are moulded by the "compression" process for which the following types² of moulds are generally employed:—

- (1) Flash moulds,
- (2) Positive moulds,
- (3) Semi-positive and subcavity moulds,
- (4) Positive flash moulds,
- (5) Positive floating chase,
- (6) Flash stripper plate and flash filler plate moulds, and
- (7) Split moulds.

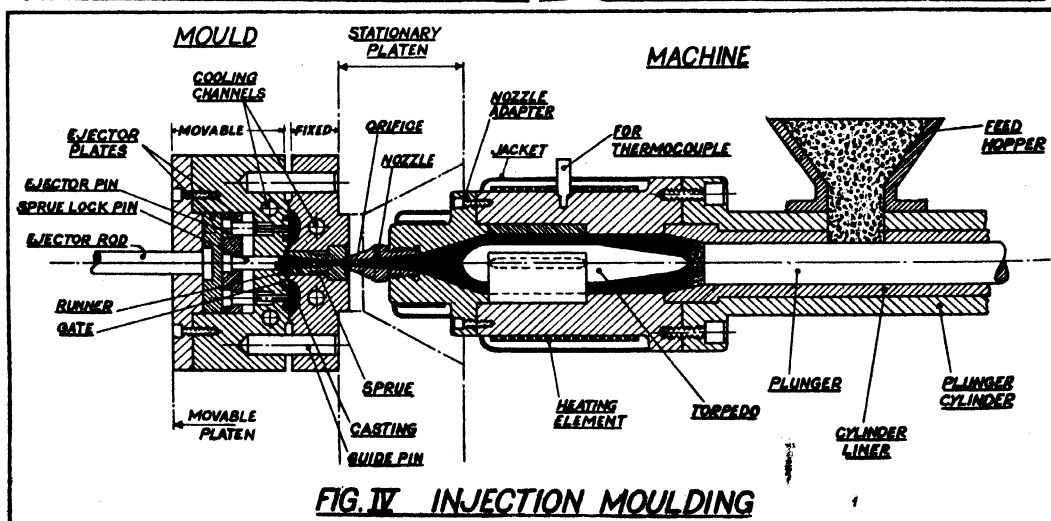
Another type called blowing moulds, which is used for the production of hollow goods (Fig. III) may also be included in this class.

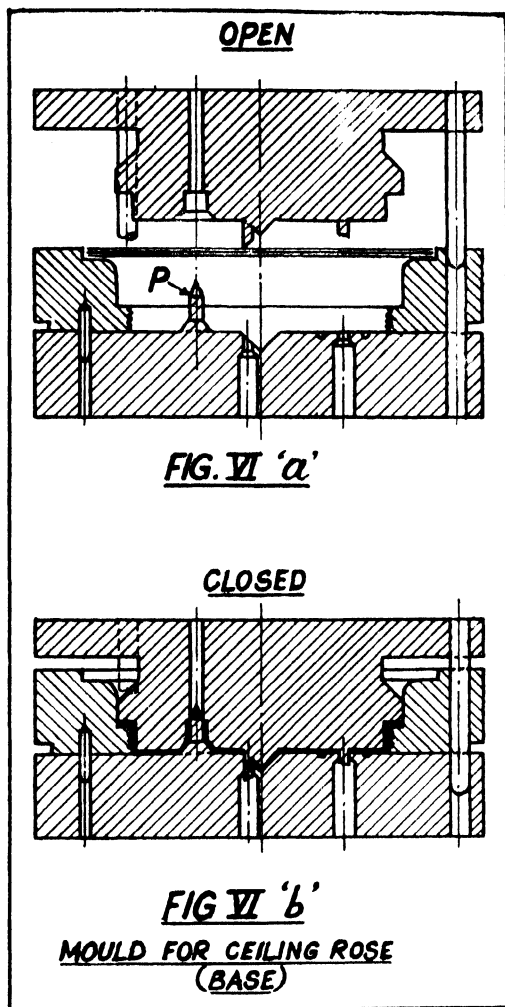
The first two types are shown in Figs. I and II; they are of interest as they apply to general moulding practice. The scope for the other moulds is somewhat restricted.

"Injection" moulding, which is used for thermoplastic materials, is well suited for rapid automatic production. The principle of injection moulding³ is illustrated in Fig. IV. The granular material is placed in a hopper and fed to a heating cylinder, from where it is forced past a spreader or torpedo

**FIG. I FLASH MOULD****FIG. II POSITIVE MOULD****FIG. III BLOWING MOULD****FIG. V 'a'****FIG. V 'b'**

MOULD FOR 50 CIGARETTE
CONTAINER (TOP PART)

**FIG. IV INJECTION MOULDING**



through a nozzle into the water-cooled, closed multiple die by a reciprocating plunger as shown in Fig. III. The extrusion process⁴ and transfer moulding⁵ may be

regarded as modified forms of injection moulding.

In addition to the above methods, a new technique⁶ for moulding articles of intricate shapes from resin impregnated laminates has been developed in the Physical Laboratories of the *Council of Scientific and Industrial Research*. These mouldings are relatively lighter and possess greater mechanical strength. The moulds for this purpose had to be designed according to a specially developed method, and required accurate construction to very narrow limits of tolerances. Figs. V (a) and (b) illustrate how fine tappers are provided to accommodate excess material at the edges of a cup-shaped moulding and to help ejection as well. Special devices (for which a patent application has been filed) are also incorporated in the mould design to facilitate the production of deep drawn articles of the type exemplified by 50-cigarette containers. Figs. VI (a) and (b) show how holes are punched and threads produced during the moulding process. Also note how pin 'P' pierces the blank and supplies the surplus material to form a countersunk hole with a tube-like projection. Numerous modifications of the process are under investigation with a view to enable complicated mouldings to be produced.

References

- 1 *Edgar Allen News*, Dec. 1945.
- 2 L. F. Rahm, *Plastics moulding*, 1933, p. 51-73; T. Delmonte, *Plastics in Engineering*, 1943, p. 344-354; H. W. Rowell, *Technology of Plastics*, 1936, p. 77-85.
- 3 *British Plastics*, May, 1945, p. 196; G. B. Thayer, *Plastics Moulds*, 1944, p. 37-82; *Plastics in Engineering*, 1943, p. 363-368.
- 4 H. R. Simons and C. Ellis, *Handbook of Plastics*, 1943, p. 562-565.
- 5 G. B. Thayer, *Plastics Moulds*, p. 33-35.
- 6 *Ind. Pat. No. 30680* (1944); *British and U.S.A. Patents pending*.



VII—TESTING

STANDARD METHODS OF TESTING PLASTICS

By G. N. BHATTACHARYA

(Indian Lac Research Institute, Ranchi)

IT is extremely difficult to test a sample of plastic material under various conditions of service into which it may be actually put. Some standard tests have, therefore, been devised to judge the merits of its moulded specimens under prescribed laboratory conditions. The importance of such tests may be gauged from the fact that no less than 95 standards under the head "Plastics" have been classified by the A.S.T.M.¹, although most of them are still in the tentative stage. The V.D.E. tests in Germany, the U.S.E. methods in France and the B.S. specifications in Britain concerning plastics may sometimes differ in matters of detail, but the broad principles and methods do not deviate much from the American practice.

Standard Tests

The more important of the usual tests on plastics are the determination of (1) Impact resistance or toughness, (2) Distortion under heat or plastic yield, (3) Cross-breaking strength or flexural strength, (4) Flammability or non-ignitability, (5) Water absorption, and (6) Tensile strength. If the material is to be used for electrical insulation, the following tests in addition to the above are also performed: (1) Dielectric strength, (2) Electrical resistivity, (3) Dielectric constant, and (4) Power factor. According to their special utility, however, many other physical properties of plastics are determined from time to time, e.g., (1) Thermal conductivity, (2) Arc resistance, (3) Modulus of elasticity, (4) Compressive strength, (5) Density, (6) Hardness, (7) Resistivity, (8) Weathering, (9) Degree of cure, (10) Shrinkage, (11) Colour fastness, (12) Fatigue strength, etc. Besides, for transparent plastics a few other

tests are also performed of which the important two are (1) Refractive Index, and (2) Degree of transparency.

Discussion

It is not possible to describe these methods here or comment on each of them. But it can be safely said that they have not received the amount of scientific scrutiny that they really deserve. For example, the determination of impact resistance, probably the most important of all these standard tests, is almost universally determined over a Charpy or Izod type machine, and it has been shown only recently² that the energy measured by such a test obscures the true impact strength of a material unless factors like the notch, rate of stressing, temperature of test and dimensions of the test specimen are properly taken into account. Similarly, it has been observed that the measurement at a particular frequency, such as 50 c/s or 1 mc/s, of some electro-physical properties, such as dielectric constant or power factor, as has been advocated in some standard specifications, may not give a true indication of the behaviour of plastics in the electrical field unless their temperature effects are also taken into consideration.^{3,4} Such points are expected to receive proper attention in the near future and stimulate further research. Very recently⁵ however, there has been a tendency to evolve a series of mechanical and electrical tests which can be applied on miniature specimens cut directly from finished mouldings. Correlation of the results of these tests with those of the existing standard methods is still under consideration.

References

- ¹ A.S.T.M., 1944, *Book of A.S.T.M. Standards*, Part 3, 16.
- ² Telfair, D., and Nason, H. K., *Proc. A.S.T.M.*, 1944, 44, 993; *Ibid.*, 1943, 43, 1211.
- ³ Hartshorn, L., *Brit. Plastics*, 1945, 17, 99, 186.
- ⁴ Bhattacharya, G. N., *Ind. J. Phys.*, 1944, 18, 1, 126.
- ⁵ Shearman, B., Fleming-Williams, B. C., Rogowsky, Z., and Strong, D. J., *E.R.A. Techn. Report*, Ref. B/T. 40, 1944.



VIII—APPLICATIONS OF PLASTICS

1. ADHESIVES FOR PLYWOOD

(a) SYNTHETIC RESIN PLYWOOD ADHESIVES

By D. NARAYANAMURTI

(Forest Research Institute, Dehra Dun)

THE synthetic resin adhesives at present used for plywood manufacture are mostly of the thermosetting type. They are the phenol-formaldehyde resin adhesives (Tego-film), the urea formaldehyde resin adhesives (Beetle glues, Weldwood glue and Aerolite glues) and melamin-formaldehyde

resins. Resorcinol-formaldehyde adhesives have been recently developed, and if they can be produced at an economic cost they are likely to be used in the future. Thermoplastic resins like *Formvar* (Polyvinyl acetal) find application in the preparation of improved woods like "hydulignum."

Phenol-formaldehyde resin adhesives usually consist of the resin in the B-stage either in alcoholic solution or in film form. Heat and pressure applied in the preparation of the plywood polymerizes the resin to the final stage.

TABLE I.

Adhesive—	Phenol-formaldehyde		Urea-formaldehyde	
			Cold setting	Hot setting
Form	Film	Suspension or solution	Syrup or powder	Syrup or powder
Concentration, %	—	40—70	60	60
Solvents	—	Water, alcohol, acetone	Water	Water
Hardeners	Incorporated	—	Can be used mixed or separated.	
Fillers	—	Blood albumen or other proteins	Wood or almond or walnut shell flour	
Extenders	—		—	
Fortifiers	—	—	—	
Working life	Over several months under proper storage	Varies	Varies with temperature and make	Melamin or resorcinol About 8 hours
Rate of spread (as dry adhesive), lbs./1,000 sq. ft.	8—10	10—20	30—50	15—30
Assembly period	Not critical day to weeks	Not critical days to weeks	Critical, varies usually, not more than 20 months	Not very critical, follow instructions
Pressing conditions—				
Favourable moisture content, %	8—12	1—6	8—12	Not critical (4—8)
Curing temperature, °F.	280—320	240—280	> 75	230—260
*Curing time (for adhesive film), min.	about 4	4—1	—	3—5
Pressure, lbs./sq. in.	100—200	100—200	100—200	100—200
*Period, hours	—	—	4—7	—
Bond Properties—				
Reaction	—	Nearly neutral to slightly alkaline.	Acidic	Acidic
Strength	High	High	High Cold water resistance. High temperatures and humidities weaken bond Unextended adhesives are more resistant than extended ones	High
Water resistance	Boil proof	Boil proof		—
Weather resistance	Very high	Very high		—
Mould and fungus resistance	Do.	Do.	Cool	Cool
Storage	Cool, in sealed packages	Cool	Several months	Several months
Storage life	Several months	Several months	6V3, 1203	6V3, 1203
Specification	6V3, 1203	6V3, 1203	Satisfactory working characteristics	
Advantages	High strength, durability, long assembly time, clean and economical, labour saving, standardised product	High strength, durability, long assembly time	—	
Disadvantages	—	—	Susceptibility to sustained heat and moisture, tendency to craze.	

The data given are indicative as there may be variation with type of make and other conditions.

* Total time will depend on the thickness of plywood, species, etc.

Urea-formaldehyde resin adhesives act at a comparatively low pH. This is achieved by the addition of a hardener which usually consists of an ammonium salt to the partially condensed resin. Resorcinol glues usually set at about neutrality.

Where great durability (high strength, weather and fungus resistance) is desired phenol-formaldehyde resin adhesives are the most reliable. They also prevent face checking in veneers. These resin adhesives have greatly extended the uses of plywood (aircraft, shipbuilding, etc.) and have facilitated the production of new products (moulded plywood, improved wood like superpressed plywood, etc.). Useful data on these adhesives are assembled together in Table I.

(b) NATURAL RESIN ADHESIVES

By S. M. KARIM

(Council of Scientific and Industrial Research, Delhi)

THE quality of plywood is largely determined by the glue used for bonding the plys. The uses to which plywood are put depend on its moisture resistance, dimensional stability, resistance to rot and fungi and on the strength of the bond, particularly at elevated temperatures. The bond strength is considered, very important, and one of the tests, called the "hot water test" for plywood, is to heat a specimen while submerged under water to a temperature of 150° F. for three hours, and to chill it after withdrawing from water. Under this treatment the bond should not be loosened.

Shellac is abundantly available in this country, but despite its good adhesive properties, it has not been used in the plywood industry presumably because of its thermoplastic property. It is known that the softening point of shellac can be raised by a process of "heat curing," i.e., by maintaining the shellac at a high temperature for some time when a change similar to polymerization observed in synthetic resins takes place¹. This property of the lac resin has been taken advantage of in formulating an adhesive composition for plywood. In the earlier experiments, a shellac-rubber composition was tried which gave satisfactory results. In the later experiments, rubber was excluded, and modified shellac was employed with an accelerator. Heat penetration measurements were carried out with piles of varying thickness placed between heated platens. From these, the optimum conditions were

determined. Resin-bonded plywoods sent to the Engineer-in-Chief, G.H.Q., have been tested and found to be satisfactory.

A cold pressing process has also been developed in the Laboratories of the Council of Scientific and Industrial Research. The product is comparable with casein bonded plywood, in respect of shear strength and tensile strength, and superior in respect of water resistance.

Reference

¹ *Ind. Lac. Res. Inst., Bull.* No. 14, 1933.

(c) "PREPARED" CASEIN GLUES

By A. JOGARAO

(Council of Scientific and Industrial Research, Delhi)

CASEIN glues have been widely used in wood-working industries for a number of years. But the advent of synthetic resin adhesives in recent times has diminished their importance to some extent. Judged from the standpoint of the superior bonding strength, water and weather resistance properties, casein adhesives must be regarded as having poor qualities as compared with phenolic and urea aldehyde adhesives, and consequently limited usefulness in the manufacture of cheap and commercial products such as plyboards. Owing to the absence of a stable synthetic resin industry in India, the use of casein adhesives is still in vogue.

Recent research on casein adhesives has not led to any new formulations which are likely to place them on a footing of equality with the synthetic resin adhesives, much less to excel them. Work carried out in the laboratories of the Council of Scientific and Industrial Research, and also in the Forest Research Institute, Dehra Dun, has, however, shown that lactic casein manufactured in India when used in accordance to the Madison formulæ for irreversible gels does result in producing the so-called "Waterproof" joints better than other known casein compositions, provided all the ingredients are of good quality and are properly standardized.

Inquiries received from firms producing casein in this country indicate the existence of a large demand for a dry casein glue composition of a "prepared" type, as distinguished from the "wet-mix" type. The composition is required to be such that it could be made into a paste by simply mixing with cold water and that, after application and bonding, the joints would

be strong and "waterproof". Almost all the water-resistant casein glues basically depend upon the solubilizing action of an hydrolyzable alkali salt on casein followed by the formation of an irreversible jelly, usually calcium caseinate, in the presence of a heavy metal or alkaline earth hydroxide. A few patents also exist wherein the hardening of proteins by formaldehyde in some form or other is taken advantage of.

Among the numerous casein-glue compositions suggested by various workers, the lime-silicate composition especially with a little copper salt was found to give the best joints. But it was not found practicable to have it as a "prepared" glue. Experiments conducted in the Council Laboratories resulted in developing a composition which besides the usual ingredients also contained about 5 per cent. of a cheap indigenous material, and it was found possible to produce it in the form of a dry "prepared" glue powder. This could readily be made into a paste by rubbing with the specified amount of water in a paint-mixing machine and applied to wood plies in the usual manner and pressed. Either cold or hot pressing could be employed, but it was always found that the hot-pressed joints were stronger and more water-resistant. The glue powder was found serviceable for use after two months' storage, without the joints showing deterioration in dry strength, although the wet shear strengths fell by about 25-40 per cent. Similar tests carried on other known casein-glue compositions showed that the "prepared" glue powders after storage for two months were not capable of giving joints with any wet-shear strength at all and with only half the original dry strength. *Mango* veneers (1/16" thick) were employed for making the plyboards; in a few experiments, *sterculia* and *sissoo* veneers were used. Veneers without knot and major flaws were selected for the tests, but in order to simulate commercially practical conditions, they were used as such without any preliminary smoothening or sand-papering of the adhering surfaces. The wet-shear strengths were measured according to standard specifications after soaking the three-ply test specimens in water for 72 hours.

The test results have shown that within the limitations inherent to casein-glues, the new composition gives stronger and relatively more waterproof joints than other "prepared" powders known in the casein trade.

2. ADHESIVES FOR POLISHING DISCS, CLOTH AND PAPER

By M. VENUGOPALAN

(Indian Lac Research Institute, Ranchi)

IN all engineering, metal and wood finishing industries, grinding discs and polishing paper or cloth are necessary requisites. There are various types of these materials at present in use depending upon the grade and fineness of the abrasive and the nature and quality of the adhesive substance which binds them together. Among abrasives may be mentioned corundum, carborundum, garnet, quartz, etc. The abrasive powders are generally bonded together by the use of vitrified clay, silicates, rubber, resins, etc., and among the resins, phenolic synthetics, have been found to produce hard and heat-resistant wheels while shellac has found special application for the manufacture of soft wheels for finishing very smooth surfaces. Shellac grinding wheels also possess considerable elasticity but suffer from the defect, that they have a low heat resistance. Their use is restricted to finishing articles under low speed which prevents the use of shellac from a wider application in this field.

As the result of researches in this *Institute*, it has been found possible to overcome this defect by suitably modifying shellac with the requisite proportions of formalin and urea in the presence of acid accelerators like maleic or phthalic anhydride (*vide, Ind. Pat. No. 29,195*).

The procedure for making grinding wheels generally followed is briefly as follows:—Abrasive grains are at first coated with resin either in the molten condition or in solution; after drying, cooling, and grinding, the coated grains are placed in moulds and subjected to heat and pressure, after which the wheels are finally cured in ovens at controlled temperature. Grinding wheels made with the modified shellac as above, have been found to withstand high speeds without bursting or softening, thereby increasing the use of shellac in this industry.

The use of shellac, however, as an adhesive in the preparation of polishing paper or cloth is rather limited, chiefly due to the fact that starchy materials, vegetable and animal proteins, etc., which form the main bulk of the adhesive medium in the manufacture of such articles, are very much cheaper than

shellac and only aqueous solutions are used. On the other hand, polishing materials made with such adhesives do not stand rubbing in presence of water and consequently their use is limited for finishing only dry surfaces. For a wider and more universal use of such materials, e.g., in metal polishing industries, in automobile and railway workshops, therefore, the compositions should be waterproof. Many synthetic resins have found application in this field, and among the natural resins the use of shellac for such purposes has not been known. Recently, adhesive compositions based on shellac suitable for preparing waterproof polishing papers or cloth have been worked out at the *Institute (loc. cit)* and have been pronounced satisfactory by an industrial concern. Thus a new line of application for shellac has been found which may tend to increase the use of shellac in the country.

3. SYNTHETIC FIBRES FROM PROTEINS,—PROLONS

By S. DAS GUPTA

(Council of Scientific and Industrial Research, Delhi)

PROLON is a generic name for all synthetic fibres obtained by processing natural proteins,—animal or vegetable. Work on prolons has been carried out in this laboratory for some years past, and out of the many raw materials tried, groundnut protein was selected. Groundnut is produced in India in large quantities, and the protein has properties similar to those of soya-bean and casein, from which fibres have already been successfully made.

Groundnut cake is extracted with salt solution, and the protein precipitated from the saline extract with sulphur-dioxide gas under controlled conditions. The protein is then washed and dried. A viscous solution of the protein in caustic soda or ammonia is prepared and extruded through fine jets into a coagulating bath containing dilute acid to which suitable metallic or organic salts are added for improving the properties of the fibres. The fibres thus obtained are treated with formaldehyde solution containing small amounts of common salt and hydrochloric acid and finally washed and dried.

The physical properties of fibres spun in this laboratory are given in the accompanying table. The properties of casein fibre spun in the same spinning equipment, and of natural wool are given for comparison.

Properties	Groundnut Fibre	Casein Fibre	Wool (Natural)
Diameter, μ	15-40	11.4-28	19-40
Fineness, grex	4.3-11.4	1.6-8.0	3.6-16.5
Sp. gravity	1.14	1.20	1.32
Moisture content, % (R.M.-74 %)	8.2	6.9	14.7
Tensile Dtrength kg./sq. in.	4.8×10^3	5.4×10^3	10.13×10^3
Maximum elongation, % (R.H.-74%)	12	60	..
Average stiffness, gm./grex.	6.7	1.5	4
Nitrogen content, %	15.4	14.2	..

The preparation of fibres requires accurate mechanical and chemical control. At present fibres have been made only on a laboratory scale and considerable development work is necessary for the adoption of the process for large-scale production. The fibres do not felt and are light brown in colour with a soft feel and good tensile properties. Thermal conductivity and burning properties are comparable to those of wool.

4. PLASTIC LAMINATES

By C. A. R. KHAN

(Council of Scientific and Industrial Research, Delhi)

PLASTIC laminates find a variety of applications in the industrial and decorative fields. Typical applications in industry are: aerial masts, bearings, gears, circuit breaker carriers, electrical insulation sheets and parts, fuse panels, etc. In the decorative field they find application in interior panelling, partitioning and furnishing, a wide variation being provided by colours and surface finishes. Thus the surface may be highly polished, satin finished or matt textured; it may be formed by a textured paper or a textile fabric as the top layer of a lamination or by using a textured plate in the veneer press.

Although India had, before the second World War, a few plastic moulding factories using imported moulding powers, there was no factory for plastic laminates. The absence of such an industry was acutely felt during the war years. The absence of a synthetic resin industry in the country was a serious setback to development. The alternative was to use natural resins such as shellac and casein, and a process comprising the use of shellac modified with casein was developed in the *Council Laboratories* for pressing laminates from paper and fabrics. No laminates from fabrics could be produced during the war due to the non-availability of heavy presses, but quite a large quantity of paper laminates were produced and are being

produced at *Rohtas Industries Limited, Dalmianagar*.

The steps involved in the process are:— (i) preparation of resin solution, (ii) impregnation and drying of the paper or fabric, and (iii) pressing. Due to the shortage of solvents and the non-availability of solvent recovery plants, the development was limited to the use of aqueous alkaline solutions to dissolve shellac and casein. In the initial stages, rubber latex in the proportion of 5 per cent. of the resin solution was used as the plasticizer. As rubber soon became unavailable, substitutes had to be found. Depolymerized lac (prepared by subjecting shellac to a pressure of 300 lbs. in an autoclave in alkaline water) served as a good plasticizer: 5 per cent. to 25 per cent. of the substitute was incorporated according to requirements.

The impregnation was carried out in a tank containing the resin solution through which paper or fabric was passed, followed by drying in a hot chamber. The material was then cut into required sizes of laminates and preheated in an oven for removing the last traces of moisture. The dried laminations were pressed together between chromium plated steel or aluminium plates at a pressure of about $\frac{1}{2}$ ton per sq. inch at 120° C. The time varied from 5 to 10 minutes according to the thickness of the board.

The laminates thus obtained had a water absorption of about 15 to 20 per cent. By curing at 80° C. for 2-3 hours under slight pressure to prevent deformation, the absorption could be reduced to 4-5 per cent. The laminates served as satisfactory substitutes for imported products at a time when synthetic resin was scarce. Work on the use of natural resins other than shellac and synthetic resins is now in progress.

5. ANTI-GAS FABRICS

By **PREM PRAKASH**

(*Council of Scientific and Industrial Research, Delhi*)

ANTI-GAS fabric is an oil-dressed fabric which resists the penetration of mustard gas. Mustard gas attacks not only the lungs and eyes which can be protected by the use of a gas mask, but also produces painful blisters wherever it comes into contact with the skin. Overall garments made from the treated fabric are required for affording protection to A.R.P. workers and decontamination squads who are on active duty during gas attacks.

In January 1941, the *Board of Scientific and Industrial Research* was approached by the Supply Department to investigate the possibilities of manufacturing anti-gas fabrics from indigenous raw materials. A technical committee was appointed under the chairmanship of Prof. Sir S. S. Bhatnagar, and research work was immediately undertaken to explore the problem. A number of varnishes were developed within a few months, and gas efficiency tests carried out at Rawalpindi in the *C. C. D. R. E.* laboratories. The products proved to be superior to imported ones in resisting gas-penetration, with a gas efficiency number varying from 12 to 14 as against 9.6 to 10 of the latter. Of all the experimental varnishes that were developed, two seemed to be most promising. They were prepared in the following manner.

I. Equal parts of linseed oil fatty acids and shellac together with 10 per cent. glycerine were heated to 125° C. The temperature was gradually raised to 180° C. and heating continued till the acid value fell to below 40. An equal amount of linseed oil containing a little slaked lime was heated to 195° C. and added to the whole. The temperature was raised to 200° C. and kept at that point till complete mixing took place. This was tested by making a bead on a clear glass plate, which should not show any opacity on cooling. The mixture was then cooled to 90° C. and cobalt linoleate added as a drier. The varnish was then diluted with white spirit and strained or centrifuged before use.

II. Double-boiled linseed oil with 10 per cent. glycerine and 5 per cent. lead peroxide was heated for 5 to 6 hours at 150° to 160° C. with constant agitation. 30 per cent. shellac was then gradually added and the temperature raised to 200° C. and kept at that point till complete mixing took place. The temperature was then brought down to 140° C. and maintained for a couple of hours, turpentine added as a thinner and the varnish strained or centrifuged before use.

Successful commercial exploitation of this important store depended upon three factors:

- (a) Production of suitable basic cloth.
- (b) Production of the varnish.
- (c) Proofing the fabric properly with the varnish.

The production of the basic cloth was entrusted to a few selected textile mills at Bombay, Ahmedabad and Calcutta. The cloth was made from fine Egyptian cotton

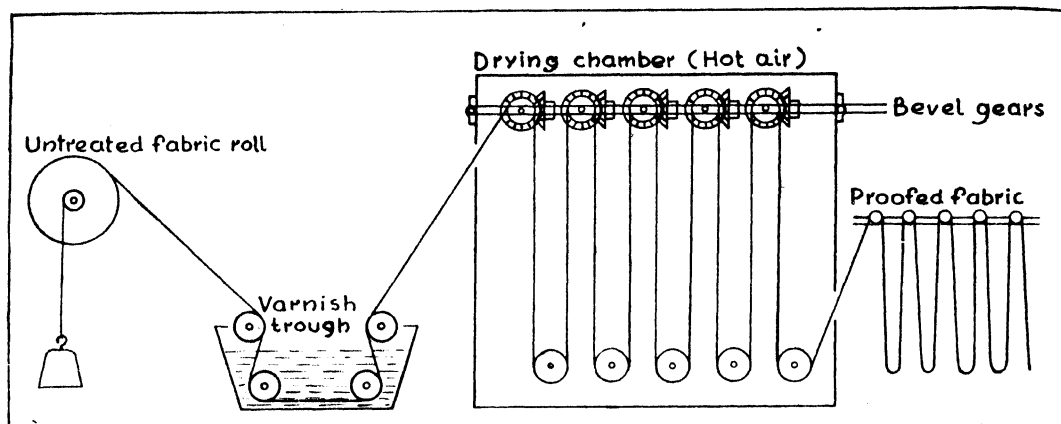


Fig. 1.

and scoured and properly singed on both sides. The cloth was examined carefully particularly for ends and picks and the warp and weft strengths and only the cloth which strictly conformed to the specifications was passed on to the proofing firms.

Anti-gas varnish was produced by several paint and varnish manufacturing firms in Calcutta and Bombay, according to the instructions issued. Since the method of preparation had been standardized in the laboratories, no difficulty was experienced in reproducing the results on a large scale. Besides taking all possible care to ensure production of good varnish, samples were tested from each lot before releasing it to the proofing firms. Only formula No. I was given to the trade, formula No. II being kept in reserve.

The most important stage in the manufacture of the fabric was the proofing of the basic cloth. For the laboratory work a machine was designed, which could be used with a variety of varnishes with drying times ranging from a few minutes to 6 hours by suitable adjustments. Fig. 1 shows the working of this machine. The optimum conditions for proofing, drying time, temperature, etc., were determined on this machine. Large-scale proofing was first started in Calcutta, a textile printing machine with slight modifications being requisitioned for the purpose. Simpler machines consisting principally of an impregnating device and a drying chamber, were later designed. After successful completion of large-scale experiments, the process was passed on to several firms in Bombay, Ahmedabad, Calcutta, Madras, Meerut, Bikaner, etc. After proofing, the fabric has to be aged for a period of 10-15 days in

order to avoid any subsequent generation of heat by slow oxidation and consequent danger of fire. Every inch of the proofed fabric was carefully examined by inspectors before being packed in rolls interleaved by cellophane or butter-paper. Samples from each lot were tested in the laboratory particularly for (i) percentage proofing, (ii) pinholes, (iii) accelerated ageing, (iv) tensile strength before and after ageing, (v) decontamination (tested by boiling the fabric with water for half an hour), and (vi) gas efficiency before and after accelerated ageing and decontamination.

According to the figures available, about ten million yards of anti-gas fabric had been produced till April, 1944.

No patents were taken for the process and it was given to the Supply Department without taking any royalties.

6. MISCELLANEOUS APPLICATIONS OF PLASTICS

By S. M. KARIM

(Council of Scientific and Industrial Research, Delhi)

Jute Mill Bobbins.—Jute mill bobbins constitute an important mill accessory used in thousands. The best wood among Indian timbers for making them is *Haldu*, but the service life of the product is short. For ensuring satisfactory performance, the bobbins should resist breakage against free fall, and the heat developed in the rim due to the friction cord should be properly distributed.

Haldu bobbins impregnated with a solution of resin in oil, have given satisfactory performance. The service life is increased

8 to 16 times. Table I gives the results of service tests in two different mills.

TABLE I.

Mill	No. of hours run	Treatment	Breakage over total period run	Average breakage frequency per hour per 1,000 bobbins in service.
			%	
A	1,352	Untreated	89	16.0
	1,352	Oil treated	68	5.4
	1,352	Resin impregnated	41	1.0
B	608	Untreated	42	5.3
	608	Oil treated	31	3.9
	608	Resin impregnated	21	0.7

Bamboo Reeds.—Reeds used in handloom weaving (Fig. 1) are made from small thin strips of the outer covering of bamboo. Due to the inherent flexibility of the strips, the finished cloth develops an uneven texture. By impregnating the reed with a 25 per cent. solution of shellac containing a little urea and drying it in an air blast at about 10-15 lbs. pressure, the flexibility of the strips is reduced by 65 per cent. Treated reeds are now in use in the Madras Presidency and have proved to be satisfactory.

Gramophone Needles.—Gramophone needles are generally made of steel. Sound reproduction from records is quite satisfactory with respect to volume, but they shorten the life of the record and give rise to scratch noise. Bamboo needles impregnated with

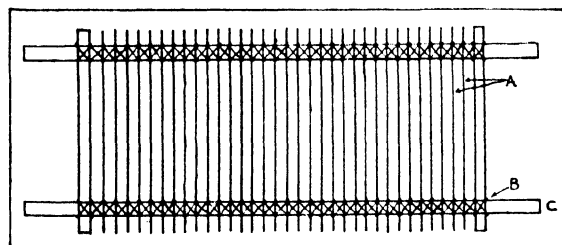


Fig. 1. A—Bamboo cover strips. B—Cotton cord binding. C—Bamboo strips for binding.

phenolic resin solution have served as satisfactory substitutes for steel needles. The sound reproduction is soft and faithful, and by sharpening with a special clipper, the point can be regenerated and its service life considerably prolonged.

Treatment of Ropes.—Extensibility of ropes under tension is a serious handicap for their commercial use. Ropes for pulley driving of machines and for baling cotton or cloth should possess very little extensibility. Coir rope of about $\frac{3}{4}$ " dia. extends by about 50

per cent. of its original length at about 8 cwt. Jute sutli rope of the same diameter has an extension of 25 per cent. at about 13 cwt. Impregnation with a resin solution and drying under specified conditions imparts to the rope satisfactory service characteristics. The extension of coir ropes has been reduced to 5-6 per cent. at its breaking load by such treatment. The value for jute sutli rope is as low as 3-4 per cent.

Fuel Pump Diaphragms.—The diaphragms used in the fuel pumps of motor cars for drawing petrol from the tank to the carburetter, are made of a flexible sheet of petrol-proof synthetic rubber $\frac{1}{8}$ " thick, or several layers (generally 4) of specially treated cloth impervious to gasoline and benzene. The diaphragms were being imported into India before the war. A satisfactory substitute has been made in India from purely indigenous materials. The composition consisting of a drying oil, a filler, a solvent, lamp black and a drier in certain proportions and mixed in proper order after thorough grinding, is coated on both sides of a desized cloth and the treatment repeated if necessary, after drying the fabric. The product is proof against alcohol in petrol as well as mixtures thereof, and it retains its flexibility at temperatures down to -30° C.

These diaphragms have been tested on military vehicles of both light and heavy types and their performance has been found satisfactory.

Rubberless Petrol Hose.—Hose pipes ranging from $\frac{1}{4}$ " to 6" internal diameter are used for pumping petrol into the refuelling lorries or on kerbside petrol fuelling stations. The hose must be petrol-proof, flexible and should not produce any gumming action on petrol. Synthetic rubber sheet properly reinforced is commonly employed for making hoses. A satisfactory substitute for rubber has been obtained from modified shellac. The composition is coated on a fabric and the hose built up.

Several hose pipes, $1\frac{1}{2}$ " dia. and 16' long, were made in the laboratory. One of the hose pipes has been in actual service with Messrs. *Burmah Shell Oil Co.* for about a year, and has been giving satisfactory service. The hose pipe is occasionally tested upto a pressure of 50 lbs./sq. in. and it is reported to be in excellent condition.

Capping Cement for Electric Bulbs.—The brass bayonet caps of all electric bulbs are cemented to the glass body of the bulb by a

special cement which should (a) be a good insulator, (b) possess sufficient torsional rigidity, (c) not deteriorate on storage, (d) be heat and water resistant, and (e) easy of application.

A satisfactory cement consisting of powdered shellac, fine marble powder, and

aluminium chloride has been formulated. The material is mixed with methylated spirit and applied to the brass cap in the form of a paste. The glass body is then pressed and heated for two minutes at 200° C. in an oven, which forms an integral part of the automatic capping machine.

"TENITE"

THE Tennessee Eastman Corporation, a subsidiary of Eastman Kodak Company, has placed on the market a new plastic under the trade name *Tenite*, the moulding characteristics and applications of which have been fully described in three attractively got up pamphlets. The Corporation produced in 1939 about twelve million pounds of tenite, a quarter of the entire U.S. production, and stepped it up by about 30 per cent. in 1940.

The moulding compositions designated Tenite-I and Tenite-II, are based on cellulose acetate and cellulose acetate butyrate respectively with suitable addition of plasticizers, dyes and pigments. They are supplied in the form of granules or blanks and can be moulded either by the compression or injection technique. Several variations in the compositions have been effected so as to fulfil special requirements in respect of moulding technique, flow, colour, transparency, toughness, and other characteristics.

In the three pamphlets are given the definitions of the properties, viz., flow temperature, impact strength, hardness, elongation, tensile strength, tensile yield points—upper and lower, flexural strength, modulus of elasticity, accelerated ageing, distortion under heat, deformation under load (cold flow), water absorption and resistance to weathering. Tables of actual test results are also appended for compositions of different formulæ designated as Tenite-I—001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 022 and Tenite-II—200, 201, 202, 203, 204, 205, 206, 236 and different flow characteristics designated as H₅ (hard, 5th degree), H₄ (hard, 4th degree), H₃, H₂, H, MH (medium hard), M (medium), MS (medium soft), S (soft, 1st degree) S₂ (soft, 2nd degree), S₃, S₄ and S₅. The specific suitability of each of the various compositions for particular purposes, such as steering wheels, musical instrument mouthpieces, knobs, containers, spectacle frames, fountain pens, vacuum cleaner

nozzles, combs, soap dishes, notebook bindings, woven handbags, lamp finials, ammunition rollers, machine keys, refrigerator drain tubes, airplane fuel lines, toothbrush handles, telephone jackshells and plugs, safety goggles, etc., is also indicated. The extent and nature of variation of Izod Impact strength at 77°F. and at -40°F., tensile strength at 77°F. and at 160°F., flexural strength and Rockwell hardness at 77°F., modulus of elasticity and elongation at 77°F., water absorption and soluble matter lost at 77°F., weight lost and shrinkage during accelerated ageing at 150°F., distortion under heat, deformation under load at 122°F., are shown in charts from the very soft to the very hard composition for the different formulæ of Tenites—I and II.

In the pamphlet dealing with Tenite moulding, a detailed description of injection moulding and compression moulding technique, and some salient points to be borne in mind in designing moulds together with sketches of typical moulds of articles like battery seal, oil-cup, spectacle case, pencil-barrel, cigarette holder mouthpiece, inkwell, etc., are given.

The pamphlets bring out the best properties of Tenite plastics for which they are highly valued, such as high impact strength and hornlike toughness, easy machineability (so that it can be punched, stamped, drilled or sawn), transparency to visible and to a great extent to ultraviolet light, wide and choicest colour range, smoothness, lightness, resiliency, resistance to perspiration and to oils, etc. Their hygroscopic nature, their tendency to soften when exposed to temperatures above 160°F., their sensitivity to acids, alkalies, alcohols and aromatic essential oils, deterioration in exposed weather conditions, etc., set limitations to their wider usefulness, but as has been pointed out in the pamphlets, by a judicious choice of Tenite of a particular designation, it should be possible to have a material satisfying most of the usual requirements.

A. J. R.

REVIEWS

Philips Technical Review

PHILIPS Research Laboratory, Eindhoven, Holland, has resumed the publication of the well-known *Philips Technical Review*, dealing with technical problems relating to products, processes and investigations of the Laboratory. The publication of the *Review* was discontinued in 1942 and with the liberation of Holland, its publication has been resumed. The January 1946 issue of the *Review*, which reached our hands recently, opens with an introduction by the editors on the occasion of its reappearance after some years of forced interruption.

The leading article relates to "Sintered Glass," by E. G. Dorgele. Application of sintered glass solves the difficulty experienced in the manufacture of articles in which many metal parts (e.g., leading-in wires) have to be fused in glass close to each other; molten glass having such a low degree of fluidity, it is sometimes impossible to press the drop of glass between the metal parts.

Pieces of glass are ground to a powder, which is placed between metal parts, and after fusing gives an imperfectly clear glass with many minute air bubbles. Particulars are given as to the properties of sintered glass and its application, and some constructions carried out by means of sintered glass are illustrated. It is pointed out that although up to the present it has been used only for special constructions for experimental purposes, sintered glass possesses so many advantages as to make it suitable for many other applications.

"Philips X-Ray Apparatus" for contact therapy has been designed to meet the requirements of medical practice. Compared with depth therapy, conditions in surface therapy are more favourable, which fact has been turned to advantage in the construction of a light and easily handled apparatus. The shape of the tube, being elongated and narrow, deviates considerably from the normal; the tube can be pressed by hand on the tumour direct (contact therapy)

without any high voltage danger for the patient or the practitioner. The focus-skin distance is 18 mm.; the own-filter is equivalent to only 0.2 aluminium.

The apparatus is fed by 50 KV direct current; the tube current is 2mA. The irradiation intensity at the point of contact amounts to 7,000—8,000 roentgen per minute, so that a few minutes' treatment is mostly sufficient. The article describing the improved apparatus emphasizes the high percentage of cures obtained with contact therapy and the advantages of this method of X-ray treatment of tumours accessible for contact therapy by means of operational exposure.

Among other articles appearing in the *Review*, reference may be made to the one on stroboscopy, i.e., the observing and photographing of rapidly moving objects. In the Philips Stroboscope the light flashes are excited by the discharge of a condenser through a tube with rare gas charge. The periodic current impulses of 2000 A thus obtained can be varied in time intervals between 2 sec. and 2/250 sec. The intensity of the light flashes amounts to abt. 200 lumen second with a maximum light flux of $2 \cdot 10^{-11}$ W (duration 10^{-6} sec.).

Synchronization of the light-flash period with the phenomenon to be investigated leads to numerous possibilities of application some of which, e.g., the examination of the cavitation of ships' screws, of the cutting process with machine tools, of the valve movement in Diesel engines, are dealt with in the article.

The annual subscription for the monthly *Review* is Rs. 14, the price of a single copy being Rs. 1-8-0.

Philips Laboratories announce the issue of another periodical, "**Philips Research Reports**," a compilation of scientific papers. The first number of Research Reports appeared in October 1945. The annual subscription is Rs. 17.

AUSTRALIAN TOBACCO INDUSTRY

THE Australian tobacco-growing industry is becoming increasingly important, and the time may not be far distant when the Australian grower will be able to supply all the national requirements, aggregating at present to 24,000,000 lbs. a year.

At present, local growers can provide only 5,000,000 lbs. for the Australian market, but the suitability of the climate and soil in several States indicates that it is only a matter of time before the industry will be able to meet local requirements, and possibly to provide a surplus for export.

Australian acreage under cultivation was highest in 1933-34, at 13,026. The lowest in recent years was 4,426 in 1944-45. This drop was due mainly to the shortage of manpower; also to concentration upon the most suitable soils for cultivation. The average production per acre of 270 lbs. in 1933-34 rose to 550 lbs. by 1942-43 due to improvements in methods of growing.

The main varieties grown in the Australian States are: Victoria: *Hickory Prior*; Queensland: *Hickory Prior* and *Gold Dollar*; Western Australia: *Hickory Prior* and *Yellow Prior*; New South Wales: *Hickory Prior*. Australians generally prefer varieties of higher textured leaf.

For a considerable time Queensland, Australia's most Northern State, has been the Commonwealth's largest producer of finest quality leaf. Queensland soils are particularly suited to the production of lighter types of leaf, and there are still considerable areas available for newcomers to the industry.

Experimental Growing

Experimental growing has recently been carried out on an Australian Army farm in the Katherine District in the Northern Territory, 220 miles from Darwin, and has yielded promising results. It is possible that this district may be added to the important producing areas.

Yields from the plantings were estimated at 800 lbs. per acre, and some of the leaves were 18" by 24". The plantings were made under the directions of the Commonwealth of Australia *Council of Scientific and Industrial Research*. It is considered that by growing in the dry season and making use of extensive irrigation, ideal conditions can be secured in this area.

Leaf imported into Australia from all countries in 1942-43 totalled 16,389,000 lbs. Imports rose to 33,372,000 lbs. for the following year. The United States supplied 12,565,000 lbs. for 1942-43 and 30,264,000 lbs. for 1943-44.

Government assistance to local tobacco producers followed the report of the 1933 *Tobacco Inquiry Committee* which inquired into the industry in North Queensland. Between 1934 and 1938, a sum of £25,000 was placed at the disposal of the *Council of Scientific and Industrial Research*, which has conducted investigations into diseases affecting the plant and tests of smoking quality.

Researches carried out by the *Council* include investigations into soil analyses, blue mould and yellow dwarf diseases, the chemistry of Australian tobacco to determine factors of smoking quality and classification and grading of Australian flue-cured tobacco.

The *Council's* discovery of a method of control of the "Downey-Mildew" in 1934 by the use of benzol enabled seedlings to be saved from this disease.

The *Tobacco Leaf Production Committee* established by the Commonwealth Government in 1944 has recommended a scheme of organized marketing, with price guarantees based on quality, and technical improvements based on production and handling. These plans are expected to result in important developments in the industry.

CHARLES LYNCH.

Reports from States and Provinces

Bengal

THE Industrial Research Laboratory under the Directorate of Industries, Bengal, is engaged not only in carrying out investigations on the availability and utilization of industrial raw materials, but also in imparting practical training in soap making, ink manufacture, preparation of adhesives, disinfectants and other industrial products. The latter activity has recently assumed considerable importance and demobilized military personnel have been taking full advantage of facilities provided by the laboratory.

Thirty-two *Bulletins* bearing on the work of the laboratory have been issued so far. They cover a wide range of subjects—bleaching of wood, utilization of waste glass, soap making and so on. In addition, research papers from the staff are published in scientific periodicals from time to time.

Proposals are on hand for expanding the laboratory to include a pilot plant section, and for enlarging facilities for research and training.

(Contributed.)

Assam

Nationalization of Industries

The decision of the Assam Government to nationalise certain industries is announced in a *communique* issued recently by the Planning and Development Department of Assam.

Under this decision, the following industries will be nationalised: (1) Cotton textiles, (2) Jute, (3) Generation of hydro-electric power, (4) Heavy chemicals, (5) Sugar and alcohol, (6) Paper, (7) Plastics and celluloid, (8) Refractories and ceramics, (9) Manufacture of light machinery, (10) Non-ferrous metals, and (11) Glass.

The Government are also considering a proposal that any new units of certain industries, namely, coal, cement, matches, motor and aviation fuel, saw mills, plywood and leather, which already exist in Assam, should be State concerns. Apart from these industries, the Government propose that whenever the establishment of a new industry or expansion of an existing industry involves a capital outlay exceeding Rs. 10 lakhs, the enterprise should be undertaken by the State.

Holkar State

The first Conference of the Textile Association, India (Indore Branch), was held on Sunday, 21st April 1946. The Conference was opened by Musahib-i-Khas Bahadur Captain H. C. Dhanda, B.A.Hons. (Oxon), Bar-at-Law, Commerce Minister, Holkar Government. The morning session was presided over by Musahib-i-Khas Bahadur Captain Dhanda, while the afternoon session was presided over by Mr. K. S. Srikantan, M.A., Director of Industries and Commerce, Holkar Government.

Mr. Srikantan dealt with the problems of the textile industry. Referring to the importance of cultivating the proper type of cotton, Mr. Srikantan said: "Although the agricultural departments, the Indian Central Cotton Committee and other research institutions had done some work in this direction,

the improvements effected were very insignificant and certainly fell short of expectations. The still greater tragedy was that the actual cultivator knows next to nothing about these researches. So long as proper efforts were not made to carry the results of researches to the home of the cultivators, money spent on research was a waste." A strong plea was made for the publication of bulletins on cotton improvement in vernaculars. The textile industry, Mr. Srikantan pointed out, was more or less in a static condition in India. In America, the industry was dynamic; no procedure or practice was regarded as permanent and improvements were enthusiastically adopted. "Experiments were frequently made to establish a balance between machine and labour efficiency. Above all, the importance of research was fully appreciated in the American cotton mills." Mr. Srikantan suggested that the Textile Association should concentrate upon improving the industry, and towards that end one or two experts should be selected to visit America and study the problems of organization and management of the progressive textile industry.

Jodhpur

Manufacture of Sodium Sulphate and Sulphide

The discovery of sodium sulphate in the subterranean brine at Didwana and the working out of an efficient process for its recovery (by Dr. J. M. Saha), have led to the establishment of a new industry.

Sodium sulphate is extensively used in the manufacture of paper and glass, in the dyeing of textile goods and in medicine. It is also used in the manufacture of sodium sulphide which is extensively used in textile dyeing and tanning.

Didwana sulphate is now being largely used in industry. The Government of Jodhpur have so far sold about 11,000 tons at the fixed price of Rs. 95 per ton f.o.r. Didwana, including gunny packing.

The whole of India's requirement of sodium sulphide is now imported from the U.K. and U.S.A. The Jodhpur Darbar have put up a large plant for the production of sodium sulphide with an annual capacity of about 3,000 tons. Didwana sulphate is the principal raw material.

The deposits of sulphate at Didwana are vast and are sufficient to meet India's entire demand for sulphate both for straight use in industry as well as for the manufacture of sodium sulphide for decades to come.

(Contributed.)

Ceylon

The Coconut Research Scheme

A memorandum issued by the Board of Management of the *Coconut Research Scheme* (1945) on its future has been the subject of lively discussions by the local planters' organizations, particularly by the Low Country Planters' Association of Ceylon.

Coconuts are estimated to account for over a million acres of cultivated land in Ceylon. The average annual export value of the products (excluding charcoal and fibre) has been about 34 million

rupees since 1929. About 750 million nuts valued at Rs. 15 millions (pre-war price. The present value will be about Rs. 35 millions) are locally consumed every year, bringing the normal total annual value of coconuts to about Rs. 50 millions.

It is against this background of an important national enterprise that the needs of the *Coconut Research Scheme* have to be judged. The present scheme was established by Government Ordinance No. 29 of 1928. Bandirippuwa Estate, situated in Lunuwila, was selected as the site for the headquarters of the Scheme, but not until the beginning of 1934 was the project in full operation. Three Departments under the guidance of three Research Officers, viz., the Technological Chemist, the Geneticist and the Soil Chemist, were set up, the Technological Chemist also functioning as the Director of the Scheme. For the extension of field experiments, a new estate, Ratmalagara Estate, was acquired in 1938, this being partly jungle land suitable for planting experiments.

The memorandum gives a succinct account of the work carried out since the scheme was inaugurated. Between 1939 and 1942, the Technological Chemist and his Assistant, collaborated with the Government Analyst and the Excise Commissioner in an extensive and successful series of experiments on the production of an improved grade of arrack by double distillation. There are now no technical difficulties in the way of the production of a superior grade of arrack, and its post-war development may be confidently anticipated. Work on toddy vinegar has been of use to the small local industry and a method has been worked out for detecting admixture with dilute synthetic acetic acid.

It has been established that manuring does not influence the oil or protein content of copra. A survey of copra from various Districts has shown very little difference in the oil content.

Much has been done to improve local charcoal production. The products of shell distillation have been closely investigated. Local soap manufacture has received significant assistance, and local oilseeds other than copra have been investigated.

The memorandum points out that far more work on the industrial side with special attention to "consumption" research is possible. It is proposed to set up a factory at the experimental station, for manufacturing on a semi-commercial scale all coconut products.

The primary work of the Geneticist relates to the improvement of the palm by selection. A careful study has been made of methods of planting in the nursery, selection of seedlings and transplantation. The demand for selected nuts and seedlings by planters has exceeded the productive capacity of the same at the *Coconut Research Scheme*. In this connection, it may be noted that the biggest problem confronting the coconut industry in Ceylon (as in Malabar) is the urgent need for extensive replanting.

In the Division of Soil Chemistry, experiments have been carried out on the effects of manures. The predominant role of potash in coconut manuring has been established. Another result has been that considerable economy is possible in the use of manures, particularly of phosphoric acid. Cover crop experiments have yielded useful information and the Soil Chemist's advice is increasingly sought by planters.

The work of the Departments has suffered seriously due to shortage of subordinate technical staff. It is pointed out in the memorandum: "Lack of

efficiency has resulted from lack of balance between the senior and junior staff and insufficient inducement for employees to remain in service. To the latter, the lack of prospects contributed even more than the actual level of salaries. In 1935 the highest maximum of a salary scale of a junior officer was Rs. 195 per mensem. There was thus a large and undesirable gap between the junior and senior staff." Among the recommendations for the future reorganization of the Scheme is the one on increase in salary scales of the subordinate staff, particularly of the Research Assistants.

Apart from the increased expenditure necessitated by enhancement of salaries, considerable capital expenditure is anticipated for setting up a factory and for the appointment of a chemical engineer and other factory staff. Total fresh capital requirements are estimated at Rs. 3,70,000. The factory idea has been criticized by the *Low Country Products Association*, who recommend in its place a Technological Laboratory and a small workshop, which "will provide small units of standard chemical plant and facilities for modification and construction of model plants." It may be pointed out here that between the criticism of laymen (such as estate owners) and the scientific evaluation of technical needs by scientists, there is often an unbridgeable gap!

Among the problems suggested for investigation are (1) the dry milling of husks with a view to obtaining a fibre dust easily combustible and rich in potash, (2) commercial uses of coconut shell distillation products, (3) preservation of coconut milk in condensed form, and (4) removal of malodorous ingredients from toddy. It is urged that a comprehensive replanting plan is necessary. The Board's view is that this should be undertaken under Government auspices, and that the function of the *Coconut Research Scheme* would be to raise and supply the necessary planting material. It is proposed also to investigate the problem of regeneration of exhausted soils in old plantations. The appointment of a Travelling Advisory Officer functioning as a conduit between the Research Station and the industry is one of the major proposals.

The financial implications of the Board's proposals are too serious to be overlooked even in a short review. The tea and rubber industries provide all the funds through cesses for their respective research institutes. That the coconut industry should similarly depend exclusively on cess revenue is claimed to be a fallacious argument, for the simple reason that coconut, unlike tea and rubber, is a national industry whose benefits to the local population are universal and difficult to appraise. It provides all the necessary fat in the diet of the population. It provides shelter for the bulk of the people. The Government should, therefore, bear at least a part of the cost of coconut research. It is suggested that the capital (Rs. 4,00,000) required should be granted by the Government. The cess should be fixed at 12 cents per 1,000 nuts and *pro rata* for other products, and that an annual Government grant should be paid which will vary with the fluctuations of the cess and be of such amount in each year as to bring the total income from cess and grant to Rs. 1,50,000.

The *Coconut Research Scheme* has now been in operation for more than a decade and it has become an integral part of the industry. It is suggested that the Scheme should henceforth be called the Coconut Research Institute.

S. R. K. M

NOTES AND NEWS

Elements 95 and 96

THE discovery of two new elements beyond neptunium and plutonium has been recently announced (*Ind. and Eng. Chem.*, 1946, 38, Reports, p. 5). Working quantities of U-238 and Pu-239 became available during the intensive researches on the atomic bomb. Bombardment of these elements with high speed alpha particles led to the discovery of the new elements. The systematic study of the new transuranium elements will lead to a clearer understanding of the chemistry of the elements above atomic number 88, which probably constitute a second rare-earth group.

Indian Linters—Grading and Utilization

Technical Bulletin No. 34, issued by the *Indian Central Cotton Committee*, deals with the analysis, grading and utilization of Indian linters. The work, which is of great interest to the infant linter industry in India, emphasizes the need for laying correct standards for grading and marketing. The potential annual supply of linters in India is 80,000 bales of 400 lbs. each. While this is small compared with the American output, which stood at 1,116,000 bales of 500 lbs. each in 1938-39, it should be remembered that the American cotton crop is 2.5 times as large as the Indian crop, and that the bulk of the American seed is of the fuzzy type, while many varieties of the Indian seed are either nearly naked or contain only a small quantity of fuzz at their apical ends. Further, there is a great demand for American linters which serves as a raw material for numerous industries, e.g., artificial silk, insulators, radio panels, non-shatter glass, bottle caps, cellulose acetate and nitrate lacquers, explosives, etc., while there is no linter-consuming industry in this country, and the bulk of the production has to be exported in competition with the highly organized American industry. These factors have been fully discussed in the *Bulletin* and valuable suggestions made for the organization of the industry.

A comparison of the commercial samples of the American linters with those produced in India reveals that the Indian product is subject to a fair amount of variation, some samples containing appreciable quantities of trash in the form of leaf, stalk or seed. There has been, however, a remarkable improvement in the quality of linters in recent years and the future for the chemical cotton industry in India is indeed bright. There is a close relationship between the fibre content and the percentage of chemical cotton in a sample; the relation can be expressed empirically by $F + f - K = \alpha$, where F is the fibre separated by the Shirley Analyser, f is the percentage of fibre below $1/16"$ given by the 'invisible loss,' K is a constant equal to 16.9, and α the dry alpha cellulose content of the air-dry linters. Based on the mechanical analysis, tentative specifications for linters have been suggested. This takes into account the percentage of "invisible loss" in the mechanical analysis, and grades can be allotted to linters on the basis of the "loss" which correspond to the results of surface grading, which is the accepted method for

giving the purchaser useful information regarding the quality of the material.

A reference is made in the *Bulletin* to a delinter fabricated in India and used in one of the factories. The Indian machine yielded a product which was not inferior to that produced by the imported machinery. The development of the chemical cotton industry in India is important as it will promote the establishment of several industries and stimulate the consumption of other raw materials. Secondly, the export of chemical cotton will bring a greater monetary return than the export of linters.

Nutritive Value of Diploid and Tetraploid Corn

Evaluation of crops in terms of constituents of nutritional significance has become increasingly important in crop production studies. Doubling the number of chromosomes brings about a 40 per cent. increase in the biologically active provitamin A fraction of yellow corn. Studies by Ellis, Randolph and Matrone (*J. Agr. Res.*, 1946, 72, 123) show that tetraploid corn is higher in nitrogen and lower in cellulose than comparable diploid corn. The composition of grain in diploid and tetraploid maize was essentially the same with respect to ether extract, ash and crude fibre. The changes in composition accompanying the transformation from diploidy to tetraploidy is attributed to the cumulative action of certain genes, notably those concerned with protein metabolism, and the non-accumulative action of others.

Dimethylamine in Tanning

The use of amines, particularly dimethylamine in the form of sulphate, is suggested for unhairing hides for sole leather manufacture, and is being tried on a works scale in the United Kingdom (*C. T. J.*, 1946, 118, 394).

Agar Agar from Indian *Gracilaria*

A variety of *Gracilaria confervoides*, available in the salt water lakes in the east coast of South India, serves as a convenient raw material for the production of agar agar (Chakraborty, *J. Proc. Inst. Chem. (India)*, 1945, 17, 188).

The process for preparing agar consists first in cleaning and washing the weed, and then extracting it with four times its weight of boiling water for six hours. The extract is filtered through cloth, poured into shallow enamelled trays and left in a refrigerator overnight. The frozen material is then thawed at about 10° C. and the water decanted. The solidified agar is cut into strips and dried in the sun. Further purification, if required, may be effected by dissolving the material in hot water, decolorizing with charcoal, and freezing the filtered solution. The agar thus produced was found to be quite satisfactory for culture media in bacteriological work and for use in the preparation of food products. The yield was 25-30 per cent. on the dry weight, and the ash content 2.5 per cent.

The quantity of *gracilaria* available in the salt water lake near Chilka is not given in the paper. Work on the preparation of agar agar has been carried out in the laboratories of the *Council of Scientific and Industrial Research* and reported in this journal (1942, 1, 98).

Tin Coating

About 40 per cent. of the tin is consumed in the manufacture of tin plate, i.e., tin-coated (thickness of coating 0.00009") mild steel plate. The *Tin Research Institute* at Middlesex, according to the latest Annual Report, has devoted much attention to the study of problems of tinplate manufacture. The usual method is to immerse mild steel plates in molten tin and the coating so obtained varies considerably in thickness and has microscopic pores through which the iron can be attacked. An improved tinning machine has been devised by means of which more even coatings can be achieved.

The scarcity of tin has stimulated considerable interest in tin plating by electro-deposition. The process of electro-tinning has come to stay and being a "continuous" process, it offers distinct advantages to manufacturers. Very thin coating of tin on steel makes an excellent foundation for paint, and increases the resistance of painted steel to rusting. A coating as thin as 0.00003" proves effective. The cost of tin required for the primary coating is only 4d. per 100 sq. ft. The process has been extended to the deposition of alloys. Thus an alloy of tin and zinc can be electro-deposited on steel without undue difficulty. This development has extended the uses of tin to the decorative field. The alloy, speculum, challenges silver, nickel and chromium as a brilliant electroplate finish. Speculum contains 45 per cent. tin and 55 per cent. copper. Its appearance resembles silver and its tarnish resistance approaches chromium.

A development which is even more important to industry is the hot tinning of cast iron. The usual expedient was to electro-deposit a coating of copper on the cast iron parts before hot tinning. In the new process, the cast surface is suitably prepared and then dipped in molten tin. The coating is continuous and keys itself into the cast iron surface.

The report also contains a brief reference to the work on bronzes. Great improvements in quality of chill castings have been secured.

The details of the processes have not been divulged in the Report. The developments referred to relate to the triennium 1942-44 and the publication of the details of these war-time researches is eagerly awaited.

The Indian Central Coconut Committee

At its meeting held at Bangalore on 20th April 1946, under the presidency of Sir Herbert Stewart, the *Indian Central Coconut Committee* decided among other things:

- (1) to locate the permanent headquarters of the *Committee* at Ernakulam;
- (2) to set up two Central Research Stations under its direct control, one for fundamental work on coconut cultivation and improvement by breeding, and the other for pests and diseases, the former at Kasaragod in South Kanara or some suitable place in Malabar, and the latter at Kayamkulam in Travancore State;
- (3) to recommend to the Provincial and State Governments to set up (a) Regional Stations for research on cultural and manurial aspects

of coconut improvement, and (b) sub-stations for control of pests and diseases;

- (4) to publish a popular handbook in non-technical language on "Coconut growing" and embodying the known methods of improvement for the use of growers;
- (5) to arrange to draw up grade specifications for copra and coconut oil with a view to standardization of the marketed products;
- (6) to depute some members of the *Committee* to Ceylon to study the technological aspects of coconut research and improvement with a view to set up a Technological Research Laboratory under the *Committee*.

The *Committee* also considered the matter of price control of copra, coconut oil and coconut cake, and expressed its views as to the levels at which the prices of these products should be fixed in the event of their coming under control.

Index of U.S. Scientific, Medical and Technical Books

The *National Research Council* of the United States Government has announced the publication of a comprehensive index of scientific, medical and technical books published in the United States from 1930 to 1944. Five thousand copies of the volume are being distributed to United States embassies, legations and libraries throughout the world. It is expected that the index will be available shortly for public reference in the U.S. Information Libraries in Bombay, Delhi and Calcutta. The Department of State endorsed the project as a means of making American science and technology available to all parts of the world.

All books listed in the volume are in print and are available for distribution in the United States and foreign countries. Distribution is being handled by the United States International Book Association at 27, East 67th Street, New York.

The volume contains a selected list of 6,000 titles of technical studies ranging from astronomy to zoology, with annotations summarizing the contents. The volume, which runs to 1,114 pages, was edited by R. R. Hawkins, chief of the Science and Technology Division of the New York Public Library.

The index to titles represents a key to the history of the development of American science and technology in the past 15 years. The editor, in an introduction, points out that twice as much material was available on the subjects listed and that selections were made of books considered most important on the subjects covered.

Because of space limitations, books in the field of social sciences, on economics, sociology, education and criminology are not included in the index. The largest number of books listed are in the field of mathematics, engineering, geology and medicine with other listings in aeronautics and agriculture.

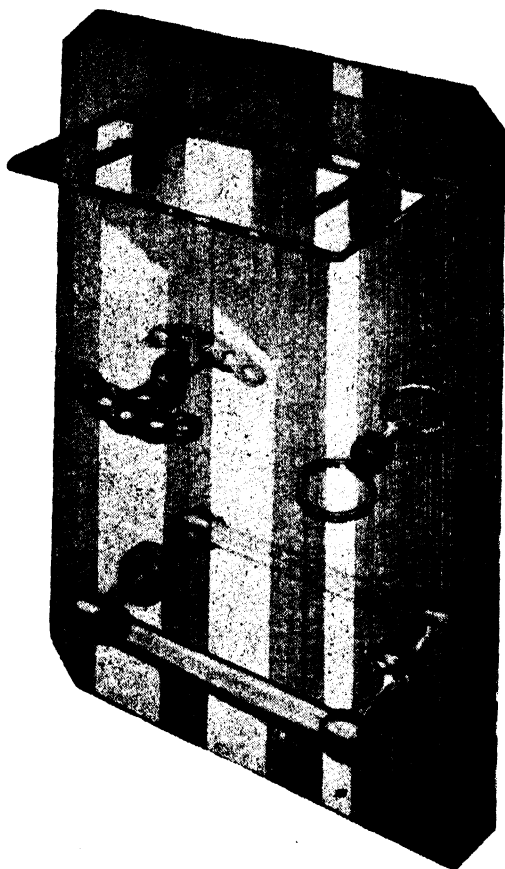
The Editor points out that the volume was planned for the use of librarians, teachers, scholars and professional and technical workers in the fields covered, as well as by all engaged in the distribution of books.—*U.S. Information Service*.

The Welding of Glass to Metal

The fusing of glass around metal wires to make sealed joints has been practised ever since ordinary electric lamps became a commercial product: but it is only in the last few years that the application of

fused metal to glass as a surface treatment has been successfully developed.

The process consists in using the "Schoop" Metal-spraying Pistol or Gun to spray finely divided fused metal on to the glass, which must be preheated to obtain adhesion. The only metals with which the process is readily effective are aluminium or alloys of aluminium with small amounts of manganese; and with these metals adhesion is secured if the glass is at a temperature of about 300° C. when sprayed. Subsequently other metals such as copper can be sprayed on to the aluminium if it is necessary to provide a metal surface which will take solder.



During the last few years research development has been undertaken on the application of fused metal to glass as a surface treatment.

A very successful application of the process originated by the *St. Gobain Company* in France is the making of electric heaters in the form of glass plates, the surfaces of which carry a resistor element in the form of a long strip of aluminium: the current passing through this strip heats the strip and the glass. Much work on developing the manufacture and testing of such heaters has been done in Britain. A heater consists of two such plates mounted face to face so that the live metal is not exposed to accidental external contact, and a temperature up to about 140° C. is conveniently obtained. The glass

plates must be toughened, this being necessary for withstanding the thermal conditions both of the spraying process and of service as a heater.

Each plate, thoroughly cleaned after toughening, is heated to 300° C. in a furnace and then placed nearly upright with a steel template or stencil over it defining the pattern of the strip to be sprayed on. The "Schoop" Gun is then used to spray the aluminium on to the glass through the template, it being necessary to complete the application of an initial coat before the temperature of the glass has fallen sensibly below 300° C. Afterwards more aluminium may be sprayed on when the plate is cold, as may be needed to adjust the thickness of the aluminium to bring the electrical resistance of the strip to the required value.

The coating of metal formed on the glass is granular in nature, composed of discrete solidified droplets each of which has acquired a thin coat of oxide. As a result the sprayed strip on the glass has a much higher electrical resistance than solid aluminium of the same cross-section: moreover, its resistance will need accurate adjustment, as shown by electrical test, and this is done by "touching-up" thin places by spraying on more metal.

Each plate is completed by spraying a patch of copper on to the aluminium at each end of the strip, and then soldering a suitable terminal on to the copper.

It is possible that sprayed metal coatings may prove useful in making reflectors and in decorating glassware. The reflectivity of the sprayed aluminium, as seen through the glass, is roughly from 55 per cent. to 70 per cent.; and, although this is less than that of ordinary silvering, the superior durability of the coat, especially in its resistance to high temperature, may give it real specific usefulness.

Penicillin and Sulphathiazole

It is generally considered that the typhoid bacillus is resistant to both penicillin and sulphonamides. An investigation by Dr. J. W. Bigger, described in a recent issue of *Lancet*, reveals that sulphathiazole in broth freed from sulphonamide-antagonizing substances, inhibited the growth of *B. typhosus* to a considerable extent. Penicillin in concentrations up to 8 units per cc. reduced but did not prevent growth. The combination of penicillin and sulphathiazole had, however, a pronounced bactericidal effect. Penicillin (4 units per cc.) and sulphathiazole (10 mg. per 100 cc.) together sterilized broth containing 70,000 bacteria per cc. The author concludes that there is no reason to doubt that by the simultaneous administration of the two drugs, typhoid bacilli would be killed *in vivo* as they are *in vitro*, provided a sufficiently high concentration of penicillin can be maintained for a sufficient time in the body (*Ind. Chem.*, 1946, 22, 60).

Better Strains of Jute

Encouraging results have been obtained by the Agricultural Research Laboratories of the *Indian Central Jute Committee* at Dacca, in their search for better strains of jute. Two new strains, C39-212 and C41-13, have been evolved and tested under local conditions in subvention farms lately established by the *Committee* in some of the typical jute-growing districts of Bengal. The two new strains have proved definitely superior as regards yield to the local variety, the mean yields being 19.75 and 20 mds. per acre respectively, for C39-212 and C41-13, as

against 17.9 mds. per acre of the local variety. (*Bull. Ind. Centr. Jute. Com.*, April 1946). On statistical analysis C39-212 was found to be significantly superior to the local. The two strains have out-yielded D.154 wherever this has been used as the local variety.

Scientific Work of the Imperial Institute

The Annual Report (for the year 1945) of the *Imperial Institute, South Kensington*, reflects the steady transition of its scientific work from war to peace conditions. It describes how inquiries for latest information and samples for analysis were received during 1945 from almost every part of the British Commonwealth—from Government departments, private firms and individuals anxious to turn local mineral, plant and animal products to the best uses in post-war industry and commerce, and from potential users seeking supplies of raw materials in short supply or difficult to locate.

Important and comprehensive inquiries have been dealt with relating to world reserves and supplies of bauxite, selenium, tellurium and beryl. Interest in the latter mineral is increasing. Assistance has been given in connection with a promising scheme, already in operation on a restricted scale, for the preparation and supply of phosphatic fertilizers in East Africa, particularly Kenya, from extensive deposits of apatite-bearing rocks in Uganda, situated near the railway and the Kenya Uganda border. Advice has also been given to the authorities in Cyprus in their desire to conserve the forests by using oil in place of wood in the local gypsum burning industry. Interest continues in the marketing of Empire vermiculite and further samples have been sent from South Africa for distribution among inquirers. The extension of the use of this mineral for heat and sound insulation purposes in ships and metal houses has been considered.

A chromium mineral from British Guiana, sent for identification, examination and chemical analysis, was found to be apparently a new mineral consisting essentially of hydrous chrome oxide, on which further work, including X-ray tests, is in progress. In contrast, a sample of ilmenorutile from the same colony, provisionally claimed to be a new mineral after an analysis in the United States, was found to be of a known type.

The perpetual problem of food, for both animals and men, has again provided much work in the past year. For cattle feeding purposes, the artificial drying of grass has been developed considerably in recent years, and in order to get the best results, accurate control of the process is necessary, and to this end samples of the product from operations in Jamaica have been investigated for their nutritional value. Of human food, cocoas from Zanzibar have been examined with a view to this commodity being produced as an alternative plantation crop in the Island, which at present has no cocoa production. Agar agar, for which the world relied on the Japanese article, is now being produced in Australia and New Zealand, and further samples from Australia examined recently were proved to be of excellent quality. In Mauritius, where cassava roots have been largely known as a war-time food measure, the question of turning the industry into an export trade has been considered, entailing the chemical examination of the prepared products. Cassava roots are the source of tapioca, of which the Dutch East Indies were large producers. Papain, a digestive agent and a "tenderiser" of meat, obtained from the pawpaw

fruit, chiefly from Ceylon and Tanganyika, has received attention in relation to steps to meet the expanding demand for this commodity. Other food materials which have been to the fore in the *Institute's* work include starches, isinglass, mangoes, palm nuts and sunflower seeds.

The report shows the important part played by the *Institute* in establishing the correct methods for evaluating Empire raw materials, the work on pyrethrum analysis recorded for the year being an example. It is further to be noted that the Advisory Councils and Consultative Committees on various groups of products, mostly suspended during the war, have resumed their activities.

The Rubber Department has devoted more time to long-range investigations, and has concentrated chiefly on the problems of producing rubber for tyres with enhanced advantages over synthetic substitutes, and the development of a new method of preparing dry rubber from latex by a continuous process. It anticipates that when production in Malaya reaches equilibrium there will be a market for special types, among which softened rubber is of great potential importance. The testing and grading of washed African rubber for the Ministry of Supply was continued throughout the year.

The Damodar Valley Authority

Quick investigation of the possibility of starting immediately the construction of the first dam (at Tilaiya) in the Rs. 55 crore Damodar River Project was recommended at a conference of the representatives of the Central Government and the Governments of Bengal and Bihar held in New Delhi on 23rd and 24th April under the chairmanship of the Hon'ble Dr. B. R. Ambedkar, Labour Member to the Government of India.

This multi-purpose scheme is intended to control the floods of the Damodar and its tributaries, provide perennial irrigation and power for the benefit of nearly 4,000,000 people living in the valley and also provide navigation facilities. The whole scheme comprises a series of eight dams and reservoirs which when constructed will impound about 4,700,000 acre-feet of water for irrigating some 800,000 acres of land and produce nearly 350,000 kws. of electricity.

After considering the reports of the Central Technical Power Board and the advice of the Tennessee Valley Authority engineers, Messrs. Ross Reigel and Fred C. Schlemmer and their associates, Rai Bahadur A. N. Khosla and Mr. M. Narasimhaiya, Chief Engineer, Mysore State, the conference was convinced of the advisability of pushing forward as rapidly as possible the scheme as a whole. It has accepted the proposals that the dams across the Barakar, a tributary of the Damodar, should be at Tilaiya (near Kodarma), and at Maithon, just above its confluence with the main river. The conference felt, however, that the start of construction of the larger Maithon dam must be postponed to October 1947, as it was not possible for both the Bihar and Bengal Governments to enter into definite commitments in sufficient time to enable contracts to be entered into with engineers and contractors, which must necessarily be done almost at once if a start were to be made by October 1946—the only other alternative. This postponement would, however, give time to consider in detail a proposal to raise the height of the dam at Maithon rather than construct a second reservoir in the mid-Barakar area. In respect of the Tilaiya Dam, it was felt that there were fewer

difficulties in making a start. Its early construction would not only provide water for irrigation and facilitate resettlement problems, but also power which would be useful in the construction of the Maithon Dam. The conference, therefore, advised quick investigation of the possibility of starting work on the Tilaiya Dam in advance of other projects.

The representatives of the Bengal and Bihar Governments stated that their Governments would not be able to carry out the scheme themselves and suggested the appointment of an authority for administering the scheme. The Government of India said they proposed to appoint Mr. B. K. Gokhale, formerly Adviser to the Governor of Orissa, to look into administrative aspects and prepare within six months a scheme for the Damodar Valley Authority.

Status and Emoluments of Scientists in India

The Government of India in the Planning and Development Department have circularized the Provincial Governments and Universities on the question of the status and emoluments of scientists. The circular draws attention to the recommendation of the *Consultative Committee of Scientists* (meeting held on 19th October 1945) that "no scientist should be given less than Rs. 200 a month either in Government service or in Universities." The *Committee* recommended that "the maximum in the case of academic scientists, not doing administrative work, should not be less than Rs. 1,500. The *Committee* consider that "the part which scientists and technicians have played during the war and must play in all future plans of national welfare and development requires greater recognition than it has hitherto received in India. In any scheme of national betterment, problems connected with agriculture, food, health, natural resources, power, transport and industries generally, will require high class scientific and technical knowledge, and in order to attract the right type of men, it is essential that the status of the scientific worker is fully recognized and protected." The scientists may be grouped under four categories, viz., those engaged in Academic Services, Defence Services, Official Civil Services and Industrial Services. A scientific worker may be defined as "a person with a degree in science, doing scientific work (including the teaching of scientific subjects)." The Government of India has asked for information on the action taken by Provincial Governments and Universities on the recommendation of the *Consultative Committee of Scientists*.

Road Development Plan for India

Addressing the Central India Centre of the *Institution of Engineers (India)* in New Delhi recently, Mr. Thomas H. MacDonald Commissioner of Public Roads in the Federal Works Agency, U.S.A., who with Major-General Philip B. Fleming recently visited India at the invitation of the Government, referred to the similarity in the matter of roads between the conditions which exist in India to-day, and that which existed in the U.S.A. 30 years ago, at the end of the last war. These are, he explained, a rapid development in the use of motor vehicles, fear of unemployment and slump, willingness of the Federal Government to supply part of the necessary money and other help for road construction and improvement and an inadequate background for research. Mr. MacDonald said that the road plan

which has been drawn up, is generally on the right lines, but emphasized the necessity of continuity. For many reasons it would be better to spread a programme over a longer period than to rush it through in a short period, building up hastily an organization for which there should be insufficient work at the expiry of the short period.

"Great importance," emphasized Mr. MacDonald, "attaches to research of all descriptions, both on the engineering problems of road construction and study of traffic trends, in any large plan of road development." He added, "I have seen some of the research work at present being done in India and have met a number of workers. Good work is being done, but it needs, in my opinion, to be expanded in many directions."

Fisheries Research Station

It is understood that the Marine Station of the projected All-India Fisheries Research Institute will be sited at Mandapam. With a good climate all the year round, a clear sea, excellent mingling of currents, shallow coasts and a fertile sea-bottom supporting fauna, Mandapam offers unique facilities for establishing the marine station. Mandapam is at the meeting point of the Palk Bay and the Gulf of Mannar, and enjoys 'the benefits of both the north-east and south-west monsoons.

The site was recently visited by Col. R. B. Sewell, Dr. Baini Prasad, Dr. H. S. Rao and Dr. T. J. Job.

Fazl-I-Omar Research Institute, Qadian

The *Institute*, which owes its inception to Hazrat Mirza Bashir-ud-Din Mahmud Ahmad, Head of the Ahmadiyya community and a great patron of knowledge, was declared open by Sir Shanti Swarup Bhatnagar on 19th April 1946. Dr. Abdul Ahad, Director of the Institute, in his welcome address, said: "The prosperity of India in the industrial field depends upon the achievements, at a fairly early stage, of two objectives. First, that our industries should be able to hold their own in the domestic market as against the products of countries that have hitherto held a lead in these matters; and, secondly, that our industries should be able to compete in the market of the world on equal terms with the products of other countries. The achievement of these objectives depends upon the progress which India is able to make in the domain of scientific and industrial research.

"This *Institute* has been founded under the directions of Hazrat Khalifatul Masih to carry on scientific and industrial research of an advanced type. The principal aim of the *Institute* is to promote the study of science and help in furthering the development of industry in India by providing such facilities as may enable workers to produce original research work of high quality.

"Every effort is being made to equip the present Laboratories with up-to-date scientific appliances, and a technical library has been provided for the use of the workers. Special arrangements are being made to provide facilities for the study of various reactions under the conditions of high and low pressure treatments. Complete equipment for micro-chemical analysis has been ordered for analytical work. Provision has also been made for the purchase of an electron microscope for biochemical research, an ultra centrifuge, and a spectrograph for quantitative analytical work.

"For the present our technical programme embraces the following lines of work:—Advanced academic research on the properties and nature of protoplasm and living matter, alkaloids and active principles of plants, synthetic drugs, biochemistry of proteins, oils, fats and carbohydrates, paints, varnishes, printing inks and lacquers, insecticides, fungicides and adhesives. Arrangements have been made for pilot plant investigations on the refining and hydrogenation of vegetable oils, and on paints, varnishes, printing inks, etc., and for the manufacture of proteinic foodstuffs.

"An initial capital grant of Rs. 2,50,000 was sanctioned by Hazrat Khalifatul Masih as the first instalment for the equipment of our temporary laboratory. Donations have been received from private individuals to the amount of Rs. 50,000.

"Arrangements are being made to provide facilities for post-graduate training for scholars from Indian universities."

Sir S. S. Bhatnagar in declaring the institute open, emphasized the importance of pure research for the advancement of applied sciences. "No applied research can flourish if isolated from pure research," he said. "The huge physical body of applied research is kept alive and fit by a constant supply of new blood in the shape of fundamental research of a pure character. Let not the enthusiasm of those interested in immediate results of a purely utilitarian character carry you away from the path of your right duty to science. India needs both pure and applied research and you should never deviate from this happy combination. Applied research may be compared to the social urge of building mosques and temples, but what use is a mosque unless the individuals and masses are imbued with the true spirit of prayer? Pure research supplies the urge for new developments and new fields of applications, and it should not be allowed to be neglected, even though we might insist upon greater expenditure being allotted to applied work.

"The second thing which I consider necessary is the proper education of the scientist. In America the emphasis on humanities had decreased to such an extent that the much dreaded monster scientist was beginning to be envisaged. Fortunately, the Americans realized that the labour-saving devices of science will soon give so much leisure to man that his brain will become a devil's workshop and, therefore, they have begun to lay greater emphasis on the compulsory introduction of courses of studies in humanity in the scientists' and engineers' curricula. You are in a fortunate position because you will always be in surroundings largely dominated by religious and cultural atmospheres. This will prevent you from becoming the purely utilitarian type of mind which the applied science may tend to make you.

"I have no doubt that the kindly and humane spirit of Hazrat Khalifatul Masih will long guide you and that this Institute will grow into a mighty organization for the good of humanity."

Council for Technical Education

The *All-India Council for Technical Education* (Mr. N. R. Sarker, *Chairman*) held its first meeting in New Delhi from 30th April—2nd May.

The *Council* passed a resolution endorsing the proposal of the Sarker Committee (set up to consider the establishment of higher technical institutions in India on the lines of the Massachusetts Institute of

Technology) to establish four technical institutions for imparting higher technical education in different parts of India. As it may not be possible to establish all the four institutions simultaneously, the institutions which are established first will cater to the needs of the whole country paying special attention to areas backward in facilities for technical education, such as the Central Provinces, Orissa, Assam and the North West Frontier Province.

The *Council* recommended that the need for upgrading the existing engineering and technological institutions was urgent. A committee will be appointed to make specific recommendations in this connection.

The *Council* endorsed the proposal of the *Indian Institute of Science, Bangalore*, for an early establishment of a post-graduate Power Engineering Department at the *Institute*.

A scheme for the training and apprenticeship of craftsmen for industries, prepared by a Committee appointed by the Government of India, was approved. The Committee suggested the need for imparting systematic training to Indian boys with a view to removing the deficiency of skilled craftsmen in the country.

Zinc Chloride Control Removed

By a notification published in the *Gazette of India*, dated 11th May 1946, the Central Government have repealed the Zinc Chloride Control Order, 1945.

Baisaki Summer Lac-Crop

The total production of the *Baisaki* lac-crop this year is estimated at 881,000 mds., as against the final estimate of 635,250 mds. last year.

The *Katki* brood-lac, which serves as seed for *Baisaki* crop was plentiful and the infection of host-trees was carried out in a satisfactory manner. Rain in February and March last was beneficial to the standing crop and if there are a few more showers in May and June, the final yield may be better than what is expected.

Dictionary of Economic Products and Industrial Resources of India

The following contributions have been received from external contributors, during the months of February, March and April 1946.

Geology

Agate (A. G. Jhingran).
Asphalt (V. N. Rangaswami).
Sands (S. Deb).
Tungsten (A. B. Dutt).

Industries

Mobile Producer Gas Plant (H. B. Dunncliffe).
Railway Communications (J. E. Castellino).
Surgical Catguts (R. H. Malone).

Announcements

It is announced that the *Royal Greenwich Observatory* will be moved to Hurstmonceux Castle in Sussex. The present observatory was built in 1675 by Sir Christopher Wren. The removal of the observatory to its new home will not involve any change in the prime meridian's longitude which was fixed by international agreement.

Birthday Honours. The following awards, among others, have been gazetted:—

K.C.S.I.: Sir Muhammad Azizul Haque, Member of the Governor General's Executive Council; member, Governing Body of the Council of Scientific and Industrial Research.

Knighthood: Professor K. S. Krishnan, F.R.S., Professor of Physics, Allahabad University; member, Board of Scientific and Industrial Research; Mr. Ghulam Mohamed, C.I.E., lately Finance Member, H.E.H. the Nizam's Government, Hyderabad (Deccan); Chairman, National Physical Laboratory Committee, Council of Scientific and Industrial Research; Major-General Gordon Covell, Director, Malaria Institute of India, Delhi.

C.S.I.: Mr. V. Narahari Rao, C.I.E., Indian Audit and Accounts Service, Secretary to the Government of India in the Finance Department.

C.I.E.: Mr. H. Crookshank, Superintending Geologist, Geological Survey of India; Lt.-Col. Desmond Roe Crone, Superintendent, Survey of India.

O.B.E.: Mr. G. R. Panjpe, I.E.S. (Retired), lately Principal, Royal Institute of Science, Bombay; Mr. H. S. Pruthi, Plant Protection Adviser to the Government of India, and Director, Locust Control, India.

M.B.E.: Dr. L. A. Ramdas, Agricultural Meteorologist, New Delhi.

Sir Shanti Swarup Bhatnagar. The Degree of Doctor of Science, *Honoris Causa* was conferred on Sir Shanti Swarup Bhatnagar, by the University of Oxford, at a special ceremony on 1st July 1946.

Sardar Bahadur Sir Datar Singh, Cattle Utilization Adviser to the Government of India, has been appointed Vice-Chairman, Imperial Council of Agricultural Research.

Sir Datar Singh, Fellow of the Royal Society of Arts, London, has been associated with the *Imperial Agriculture Research Council* since 1933. He is a specialist in the science and practice of dairying and has taken keen interest in animal husbandry problems in India. He represented India at the *International Dairy Conference, Copenhagen*, in 1931, and in Berlin in 1937. As non-official Adviser to the Government of India he went to England in 1937. He also served as non-official Adviser to the Government of India in the Indo-Japanese trade negotiations. He is a member of the *Central Food Advisory Council*, member of the *General Policy Committee* and member of the *Export Advisory Council*. More recently he led the Indian Industrial Delegation to Australia and New Zealand.

Since taking over charge as Cattle Utilization Adviser in August 1944, he has been organizing the *Gowshalas* and *Pinjrapoles* in India to work on improved lines, so that instead of their being an asylum for old and infirm animals, they should also function as centres for improving cattle breeds and milk yields. His schemes have been sanctioned in most of the provinces. He has been helping in



SARDAR BAHADUR SIR DATAR SINGH

organizing the salvage of dry cattle and in the enforcement of restrictions on the slaughter of useful cattle.

The All-India Manufacturers' Organization is sending a Delegation of industrialists and manufacturers (popularly known as "A.-I.M.O. Delegation") to the United Kingdom, the United States of America, Canada, and the Continent of Europe, sailing from Bombay on 21st June 1946, and expecting to return after about four months. The Delegation consists of the following:

Sir M. Visvesvaraya, Mr. Sankalchand G. Shah, Mr. S. N. Haji, Mr. Murarji J. Vaidya, Mr. Hansraj Dhandra, Mr. Hansraj Gupta, Mr. Ranjit Singh and Mr. G. V. Puranik.

The objects of the Delegation are:

(a) To study the latest developments in the industrial and economic spheres, (b) to make contacts with leading industrialists, technicians and manufacturers' organizations similar to the A.-I.M.O., (c) to gain firsthand knowledge of the technical advances in industrial machinery and machine plants and methods and processes of production in specific industries, and (d) to be acquainted with the post-war plants, labour conditions and the methods of labour legislation and welfare in the countries to be visited.

Sir T. S. Venkatraman has endowed a prize of the value of Rs. 500 to be awarded under the auspices of the *Sugar Technologists' Association of India* to any person contributing a paper or article showing the greatest practical improvement in the cultivation of sugarcane or the manufacture of the end product including sugar and *gur* and by-products in the preceding year. A Committee to examine the papers has been formed, and papers, articles, etc., may be sent to the Secretary of the Association, Nawabganj, Cawnpore, by 31st August 1946.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for March-April, 1946. Patents from the *Council of Scientific and Industrial Research* are indicated by an asterisk.*]

32908. BLOOD-COAGULATING AGENT: *From animal brains.*—Unip S. A.
32942. DRAFTING MECHANISM FOR TEXTILE FIBRES: *Top second-line drafting roller being rotatably mounted in a carrier member.*—The Indian Casablanca High Draft Co., Ltd. and Permyner.
32993. SUCTION CLEANERS: *Dirt filter casing so mounted that in one position dirt laden air flows through it while dirt could be removed in different position.*—Hoover Ltd.
33009. DIRECT REDUCTION OF IRON ORES: *Hot reducing gas is passed upwardly through multiple-hearth furnace in counter current relation to the ore.*—Coast Reduction Inc.
33046. REDUCTION OF IRON ORES AND ENHANCEMENT OF GASES: *Use of reducing gas consisting essentially of hydrogen, and methane with minor amount of CO, CO₂, HSO₃, H₂O.*—Cope, Brassert, and Thomas.
33139. ELECTRIC PLUG AND SOCKET CONNECTIONS: *The switch arm interlocks such that the plug pins cannot be inserted unless the switch is "off".*—Dorman & Smith, Ltd. and Lund.
33255. MEANS FOR INDICATING SOUND PITCH OR VOICE INFLECTION: *Inflection indicator comprises amplifier, fitters, distributing and mixing network, vibratory keys, impulse generator, indicators and switch.*—Horvitch.
33302. ROTARY OIL MILLS OR GHANNIS: *Mortar supported from below on vertical block having a crown wheel meshing with bevel wheel on driving shaft.*—Khalsa Engineering Wks.
33556. IMPLEMENT CONTROL MEANS FOR TRACTOR MOUNTED AGRICULTURAL IMPLEMENT: *Draft pressure on the implement, through a pressure fluid device, causes variation in the length of the link means to rock the implements.*—Harry Ferguson Inc.
33696. SPLITTING FATTY MATERIALS: *Contacting fat and water in a counter current way at high temperature.*—Emery Industries, Inc.
30665. LIQUID CONTAINERS: *Narrow strip-like and rigid supporting members secured on the exterior of flexible non-metallic envelope.*—I.C.I. Ltd.
30875. HEAT EXCHANGE DEVICES: *Matrix elements located accurately in spaced relation within aperture in header plates by spacing members between elements bridging apertures.*—I.C.I. Ltd.
31138. ARTICLES MADE OF MAGNESIUM BASE ALLOY CONTAINING ZIRCONIUM: *Impact forging in magnesium base alloy containing zirconium.*—Magnesium Elektron Ltd.
31534. GAUGES FOR MEASURING OR CHECKING THE EFFECTIVE DIAMETERS OF SCREW THREADS: *Successive convolution of wire to engage the successive grooves of the work on the effective diameter generator of the thread.*—Gabbey.
31716. DRAFT OF HITCH MECHANISMS SUCH AS FOR TRACTORS: *Front end portion of the draft member hingedly connected to a standard for tilting motion in a generally fore and aft direction.*—Harry Ferguson, Inc.
31924. AIR PICK-UP SYSTEM: *A part of the connecting line is constructed of synthetic fibre having high tensile strength, at least 10 per cent. elongation and long elastic memory.*—All American Aviation, Inc.
31988. ELECTRIC MEASURING INSTRUMENTS: *A multi-range A.C. and D.C. measuring instrument with a transformer, rectifier and shunt, with means to cancel out the resultant transformer ampere-turns.*—Automatic Coil Winder and Electrical Equipment Co., Ltd.
- *32486. BENZIDINE: *Reducing nitrobenzene with current having density 4 amp. or less per sq. dm.*—Dr. Dey, Govindachari and Rajagopalan.
32704. ELECTRIC REMOTE CONTROL APPARATUS: *Transmitter sending series of impulses, consisting an impulse of predetermined duration followed by impulses of shorter duration; receiver is responsible to shorter impulses after the received longer impulse operates some means.*—The Rudolph Wurlitzer Co.
33047. COVERING OF ELECTRIC WIRES: *Covering electric wires with insulating material by the longitudinal method without any break in continuity of movement.*—Callender's Cable & Construction Co., Ltd.
- *33058. RUBBER LINING OF NON-CONDUCTING SURFACES: *Coating the surface with barium chloride solution and applying rubber latex in spray.*—Sir J. C. Ghosh, Verghese and Dr. Rau.
- *33078. PARA-AMINOPHENOL: *By the electrolytic reduction of nitrobenzene in the presence of mercury and/or cerium or their salts.*—Dr. Dey, Govindachari and Rajagopalan.
33237. GRINDING MACHINES: *Upper stone supported by a spindle at the bottom, which can adjust the clearance between the stones by turning.*—Patel.
33625. FORMING AND EJECTING DIE CASTINGS: *One of the dies is shaped to form coating camming surfaces on the die and the resulting casting, which are utilized to eject casting automatically.*—Plasco Ltd.
33678. OSCILLOGRAPHS: *Produces plurality of traces on a screen and the intensity of at least one is varied periodically along the trace.*—The Mullard Radio Valve Co., Ltd.
33710. GAS-FIRED WATER HEATERS: *Of the kind in which a self-closing valve regulates gas supply and is automatically opened by pressure of water flow.*—Peet.
27032. HIGH QUALITY STEELS: *Intermixing a bath of metal with a basic slag having as a basis lime, alumina and silica.*—Societe D'Electro-Chimie, D'Electro-Metallurgie et Des Acieries Electriques D'ugine.

Journal of Scientific and Industrial Research

QUATERNARY AMMONIUM COMPOUNDS AS TEXTILE AUXILIARIES

By P. N. BHATT, T. N. MEHTA and V. B. THOSAR

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Polytechnic, Delhi)

QUATERNARY ammonium compounds containing a long chain of carbon atoms, although of recent origin, have found numerous applications in different textile processes. This class of compounds, also named cation-active, act according to the precise constitution and the conditions under which they are applied as fixing agents for dyes, mordants and resists in printing, stripping and levelling agents, water-repellent and anti-crease finishing agents, etc. Commercial products like *Sapamines* (SCI), *Fixanol* (ICI), *Solidogens* (IG) and *Sandofix* (S) are used to increase the fastness of substantive dyes to washing, perspiration and milling¹⁻⁴. *Lissolamines* (ICI) and similar compounds are used for stripping fast azoic and vat dyeings from fibre. Evans and Piggot⁵ have supplemented the use of quaternary ammonium compounds as stripping agents by quaternary phosphonium and ternary sulphonium salts with long chain substituents. These are used alone for stripping basic dyes and along with alkali and hydrosulphite for azoic, alizarine and vat dyes. Quaternary ammonium compounds when added to dyebaths are found to give good level-dyeings by restraining the rate at which the dye attaches itself to the fibre. These compounds are also used for increasing the affinity of leuco-sulphuric ester salts of vat dyes, so that several of these which would otherwise be useless on account of their low degree of substantivity, can be used for dyeing and printing cotton⁶. Another important application of this class of compounds is their employment as reserving agents in printing. A fast colour resist is produced by using a quaternary ammonium

agent, along with a rapidogen colour, so that after padding with indigosol and treating with acid oxidizing agents, both the ground colour and resist colour are developed⁷. When vegetable fibres are treated with cation-active substances like quaternary ammonium compounds, they become substantive to negatively charged particles of acid dyes⁸. Quaternary ammonium, phosphonium and ternary sulphonium compounds are also of importance in dyeing of cellulose acetate rayon. Actually they allow this type of rayon to be dyed in fast shades by means of acid and chrome mordant dyes which otherwise would have very poor affinity for these fibres⁹. Compounds of type of *Sapamine* find further use in dyeing solid shades on union fabrics containing cotton, wool, viscose and cuprammonium rayons¹⁰. These compounds are also recommended for finishing processes because they increase the absorption of finishing components and impart a good handle to the cloth. The production and use of the compounds of the type of *Velans* in finishing as waterproofing and anti-crease agents have made notable progress in recent years¹¹.

A detailed study of these important classes of compounds has been undertaken in these laboratories with a view to correlate the effect of various groupings on their activity. Mehta and Trivedi¹² prepared pyridinium compounds from α -brominated-fatty-acid-amides and studied their properties as textile auxiliaries. A study of the properties of pyridinium and quinolinium compounds derived from alkyl halides containing odd number of carbon atoms is undertaken in the present work with a view to compare their

behaviour with similar compounds derived from alkyl halides containing even number of carbon atoms.

Experimental

(A) *Preparation of alkyl pyridinium and quinolinium halides derived from alkyl halides containing odd number of carbon atoms.*—Alkyl pyridinium halides were prepared by the reaction of dry pyridin with respective alkyl halides as described by Mehta, Mehta and Thosar¹³. The following compounds were prepared.

The corresponding quinolinium iodides were prepared by heating a mixture of freshly distilled quinoline (5 gm.) and alkyl iodide (5 gm.) on a boiling water bath under reflux for 10-12 hours. The reaction mixture after cooling was repeatedly extracted with dry petroleum to remove unreacted constituents. The residue was dried over phosphorous pentoxide under vacuum for 2-3 days and finally crystallized from a mixture of benzene and petroleum.

(B) *Preparation of cetyl and stearyl pyridinium and quinolinium bromides.*—Stearyl alcohol (25 gm.) was heated with 48 per cent. hydrobromic acid (40 gm.) for 2 hours after which con. sulphuric acid (13 c.c.) was added and heating continued for about 8 hours. The reaction mixture was alternately washed twice with water and sulphuric acid to remove unreacted constituents. The residue was extracted with petroleum ether and finally washed with water till free from acid. The petroleum extract was then dried over anhydrous sodium sulphate and the petroleum distilled over. The residue of stearyl bromide was then distilled under vacuum. Cetyl bromide was obtained in a similar manner from cetyl alcohol.

Stearyl and cetyl pyridinium and quinolinium compounds were prepared from the respective bromides according to the method described in (A).

(C) *Titration of alkyl pyridinium compounds with acid dyes.*—When a solution of alkyl pyridinium compound is added to a solution of an acid dye, the dyestuff is precipitated. As could be seen from Table IV, the precipitation could be made quantitative if the titrations are carried out in hot solution. A solution of pure alkyl pyridinium compound of known strength is added to a hot solution of an acid dye shaking well till the supernatant liquid becomes colourless. The percentage

purity of the acid dye could be calculated if its molecular weight is known.

(D) *Sinking Tests for comparing the wetting power.*—These tests were carried out by using round discs of 1.125" diameter cut from standard quality of woollen cloth (Dhariwal flannel No. 1) and canvas. A thin wire bent at one end and made into a loop at the other, was used to keep these discs in position in the solution. A fine string of negligible weight and of 4-5 cms. length was attached to the loop by one end, while a pin (46.2 mg.) bent at an angle of 60° was tied to the other end. The disc was attached to the pin in such a way that the lines of the flannel are always vertical; the iron wire was lowered into the cylinder containing 200 cc. of the solution, so that the bend of the wire rested on the side of the cylinder and the disc remained upright

TABLE I. *Alkyl-pyridinium halides.*

Py, pyridinium; Br, bromide; I, iodide; Cl, chloride.

Compound	Empirical formula	M.P. °C.	Nitrogen	
			Found %	Calc. %
Heptadecyl-Py-Br.	C ₂₂ H ₄₀ NBr.	66-67	3.6	3.5
Pentadecyl-Py-Br.	C ₂₀ H ₃₆ NBr.	58-60	4.0	3.8
Tridecyl-Py-Br.	C ₁₈ H ₃₂ NBr.	54-55	3.7	4.1
Heptadecyl-Py-I	C ₂₂ H ₄₀ NI	111-112	3.5	3.1
Pentadecyl-Py-I	C ₂₀ H ₃₆ NI	105-06	3.3	3.3
Tridecyl-Py-I	C ₁₈ H ₃₂ NI	102-03	3.9	3.6
Undecyl-Py-I	C ₁₆ H ₂₈ NI	92	4.1	3.9
Pentadecyl-Py-Cl	C ₂₀ H ₃₆ NCl	68	4.4	4.3

TABLE II. *Alkyl-Quinolinium Iodides.*

Qu, quinolinium; I, iodide.

Compound	Empirical formula	M.P. °C.	Nitrogen	
			Found %	Calc. %
Heptadecyl-Qu-I	C ₂₆ H ₄₂ NI	97	2.9	2.8
Pentadecyl-Qu-I	C ₂₄ H ₃₈ NI	89	2.8	3.0
Tridecyl-Qu-I	C ₂₂ H ₃₄ NI	85	3.6	3.2

TABLE III. *Cetyl and Stearyl Pyridinium and Quinolinium Bromides.*

Py, pyridinium; Qu, quinolinium; Br, bromides.

Compound	Empirical formula	M.P. °C.	Nitrogen	
			Found %	Calc. %
Cetyl-Py-Br.	C ₂₁ H ₃₉ NBr.	61-62	3.5	3.7
Cetyl-Qu-Br.	C ₂₅ H ₄₀ NBr.	92	3.0	3.2
Stearyl-Py-Br.	C ₂₅ H ₄₂ NBr.	73	3.3	3.4
Stearyl-Qu-Br.	C ₂₇ H ₄₄ NBr.	106	3.0	3.0

TABLE IV. *Percentage purity of an acid dyestuff (Oxamine-Violet)*

Py, pyridinium; Br, bromide; I, iodide.

Compound	Mol. Wt.	cc. of 0.1% solution required for 10 cc. of 0.025% dye solution	Purity of dyestuff %
Tridecyl-Py-Br.	342	19.25	81.4
Pentadecyl-Py-Br.	370	20.7	81.6
Heptadecyl-Py-Br.	398	22.0	80.5
Tridecyl-Py-I	389	21.0	80.4

in solution. The time of sinking was determined for solutions of different concentrations at different temperatures. Five readings were taken for each concentration and temperature and the mean taken as the representative figure for that particular condition. The results obtained are given in Table V. The effects of temperature on sinking times using different pyridinium iodides are graphically represented in Fig. 1.

TABLE V. *Sinking Tests.*

Compound.	Wool.			Temperature C.	Cotton.		
	0.1%	0.05%	0.025%		0.1%	0.05%	0.025%
Heptadecyl-Py-Br.	1.7	4.0	8.5	70	46	57	82
	2.0	5.0	11.5	65	62	66	92
	2.2	6.0	15.0	60	60	75	111
	2.5	7.5	22.0	55	68	90	..
	3.0	10.0	32.0	50	..	..	..
Pentadecyl-Py-Br.	2.0	5.5	10.5	70	50	63	88
	2.2	7.0	14.0	65	55	68	101
	2.5	7.5	17.0	60	63	98	115
	3.0	9.0	23.0	55	70	98	134
	3.2	13.0	38.0	50	..	..	..
Tridecyl-Py-Br.	3.0	7.0	11.5	70	54	73	99
	3.5	8.5	16.0	65	55	78	108
	4.0	11.0	21.0	60	72	90	123
	4.5	14.0	27.0	55	78	103	150
	5.0	18.0	42.5	50	..	..	..
Heptadecyl-Py-I.	1.0	3.5	8.5	70	40	52	74
	1.2	4.0	11.0	65	44	..	85
	1.7	5.0	14.5	60	51	72	98
	2.0	7.0	22.0	55	60	82	..
	2.5	9.0	30.0	50	..	..	..
Pentadecyl-Py-I.	1.0	4.5	11.0	70	43.5	57	78
	1.2	5.5	13.0	65	47.0	63	90
	1.5	6.5	16.0	60	52.5	72	102
	2.0	8.5	25.0	55	57.0	84	120
	2.2	11.0	36.0	50	..	..	..
Tridecyl-Py-I.	2.7	6.0	12.5	70	59	79	107
	3.0	8.0	15.0	65	66	90	122
	3.5	10.5	19.0	60	80	98	134
	4.0	14.0	30.0	55	94	110	..
	4.5	17.0	40.0	50	..	..	..
Undecyl-Py-I.	5.0	10.0	15.0	70	87	113	..
	7.0	14.5	23.0	65	95	126	..
	8.0	16.5	27.0	60	102	..	..
	9.0	22.5	43.5	55	..	..	..
	10.0	33.5	62.0	50	..	..	..
Heptadecyl-Qu-I.	Solubility was very low and 0.1% sol. was not obtained.						
Cetyl-Py-Br.	2.0	5.5	12.0	70	54	75	105
	2.5	6.2	16.5	65	60	88	115
	2.5	8.0	21.0	60	72	94	142
	3.0	10.0	28.5	55	82	102	..
	4.0	15.0	40.0	50	103	..	..
Cetyl-Qu-Br.	2.0	5.2	12.5	70	55	72	100
	2.3	6.3	14.5	65	62	84	115
	2.6	7.2	19.5	60	70	100	147
	3.0	9.0	25.0	55	76	120	..
	3.7	11.5	30.6	50	121	..	..
Stearyl-Py-Br.	1.7	4.5	11.0	70	45	69	97
	2.0	5.5	14.5	65	55	82	..
	2.2	7.0	20.0	60	66	98	..
	2.7	8.0	27.0	55	78	118	..
	3.7	14.0	38.0	50	97	..	..
Stearyl-Qu-Br.	2.0	4.0	11.5	70	40	62	95
	2.5	5.2	14.0	65	49	74	108
	2.7	6.5	19.0	60	59	85	123
	3.5	9.0	28.5	55	71	100	..
	4.0	12.0	38.0	50	..	..	..

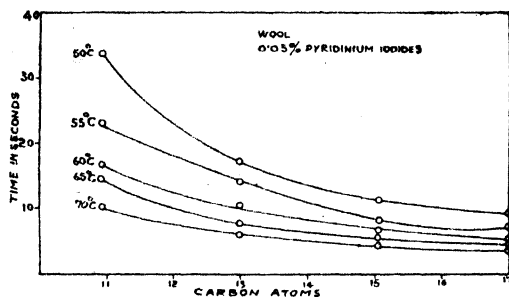


Fig. 1.—Effect of temperature on sinking time.

Conclusions

1. The wetting power increases as the molecular weight increases.
2. The wetting power of an alkyl pyridinium iodide is greater than the corresponding alkyl pyridinium bromide.
3. The wetting power increases with increase in temperature.
4. Titration with oxamine violet solution clearly shows that the precipitation is

quantitative and that the method could be advantageously used for determining the percentage purity of an acid dyestuff.

References

- 1 *Soc. Chem. Ind., Basle*, B. P., 464,142; *Friedlander*, 1927, 16, 2113.
- 2 *I. C. I., E. P.*, 398,175; *J. Soc. Dyers Col.*, 1934, 50, 32.
- 3 *I. G., E. P.*, 435,388; *J. Soc. Dyers Col.*, 1936, 52, 147.
- 4 *S., E. P.*, 464,921; *J. Soc. Dyers Col.*, 1937, 53, 413.
- 5 *I. C. I., E. P.*, 444,169; *J. Soc. Dyers Col.*, 1936, 52, 272.
- 6 *E. P.*, 443,588; *J. Soc. Dyers Col.*, 1936, 52, 322.
- 7 Durand and Huganin, A. G., *E. P.*, 445,224; *J. Soc. Dyers Col.*, 1936, 52, 322.
- 8 *E. P.*, 440,647; *J. Soc. Dyers Col.*, 1936, 52, 280.
- 9 *E. P.*, 437,274; *J. Soc. Dyers Col.*, 1936, 52, 115.
- 10 *Soc. Chem. Ind., Basle*, E. P., 366,981, *Friedlander*, 1932, 19, 2430.
- 11 *I. C. I., E. P.*, 466,817; *J. Soc. Dyers Col.*, 1938, 54, 42.
- 12 *I. C. I., E. P.*, 466,817; *J. Soc. Dyers Col.*, 1940, 56, 343.
- 13 *J. Ind. Chem. Soc., News Ed.*, 1940, 3, 142, 173.

HYDROLYSIS OF MEMBERS OF NAPHTOL AS SERIES

By T. N. MEHTA and V. B. THOSAR

(Government of India Delhi Polytechnic, Delhi, and University Department of Chemical Technology, Bombay)

THE ever increasing importance of the members of Naphtol AS series in dyeing and printing processes has led various workers to investigate the constitution of individual members of the series. These compounds being of the nature of arylamides derived from acids like 3-hydroxy naphthoic acid, 2-hydroxy anthracene-3 carboxylic acid, hydroxy-carbozole-carboxylic acid, acetoacetic acid, ternaphthaloyldiacetic acid, etc., the methods used for the investigations were principally those of hydrolysing the naphtol into its basic and acidic components and identifying them.

Rowe and his collaborators¹ hydrolysed the naphtols by dissolving the substance in concentrated sulphuric acid, diluting the solution with water to boiling point 140-45° C. and heating under reflux for several hours. Rowe and Gibbs² modified the above

method by using concentrated sulphuric acid (98 per cent.) and heating on a water bath. Both these methods had their own drawbacks in the form of charring and frothing and consequently low yields in the case of the former, and sulphonation of the component parts in the case of the latter.

Ueno and Suzuki³ hydrolysed the naphtols by 50 per cent. caustic soda at about 200° C. in an autoclave and obtained the components in unmodified form in good yields. Desai and Mehta⁴ have also followed this method of hydrolysis to determine the constitution of some new members of the series like Naphtols AS-LB, AS-SG, AS-SR, AS-LG and AS-L₃G. Hopper, MacGregor and Wilson⁵ used alcoholic KOH (16 per cent.) mono-ethanol amine, di-ethanolamine and tri-ethanolamine as hydrolysing agents and

found that the hydrolysis was nearly complete in about 6 hours.

While carrying out the hydrolysis of some members of Naphtol AS series with 16 per cent. alcoholic potash in this laboratory, it was subsequently found that Naphtol AS-LB, an arylamide of 3-hydroxycarbazol-2-carboxylic acid, was not appreciably hydrolysed by this reagent and a major portion remained unhydrolysed even at the end of 12 hours.

It was, therefore, decided to study the hydrolysis of the members of Naphtol AS series by alcoholic potash in detail and find out the various factors affecting the course of hydrolysis.

Experimental

Hydrolysis of Naphtol AS.—Naphtol AS (about 0.5 gm.) was accurately weighed in each of two conical flasks (capacity 250 cc.), 100 cc. of 16 per cent. alcoholic potash (filtered through sintered glass crucible IG4) added and heated on a boiling water bath under a reflux condenser for five hours. The contents of one of the flasks were then diluted with about 200 cc. of distilled water, neutralized with 15-20 cc. of sulphuric acid (2 N). The precipitated naphtol was filtered through a weighed sintered glass crucible (IG4), washed first with 5 per cent. sodium bicarbonate solution to remove 3-hydroxynaphthoic acid and then with distilled water till free from soluble matter. The crucible with its contents was then heated at 110° C. to constant weight and weighed. The contents of the second flask were kept overnight, diluted and neutralized next morning.

TABLE I.

Weight of naphtol taken, gms.	0.4818	0.5005
Alcoholic potash added, cc.	10	10
Duration of heating, hrs.	5	5
Weight of unhydrolysed naphtol, gms.	0.3057	0.3203
Unhydrolysed naphtol, %	63.5	64
Hydrolysed naphtol, %	36.5	36.0

TABLE II. Results obtained by varying the quantities of alcoholic potash (strength remaining constant, 13.3 per cent.) and time of heating.

Weight of naphtol AS taken, gms.	0.2460	0.5035	0.5042	0.5023
Alcoholic KOH added, cc.	10	20	10	10
Duration of heating, hrs.	5	5	5	10
Weight of precipitate, gms.	0.1871	0.3954	0.3864	0.2738
Unhydrolysed naphtol, %	76.0	78.5	76.6	54.5
Hydrolysed naphtol, %	24.0	21.5	23.4	45.5

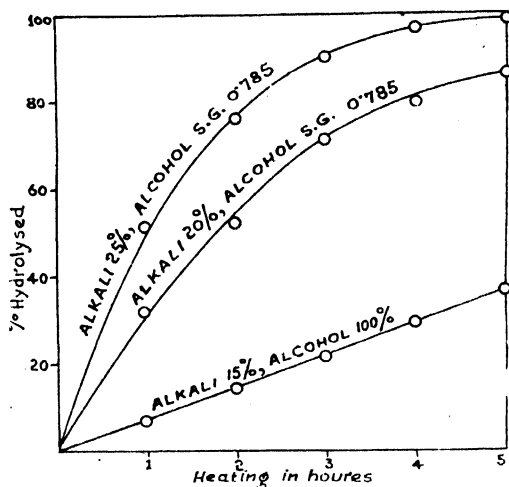


Fig. 1.—Rate of Hydrolysis of Naphtol AS with different strengths of Alcoholic KOH.

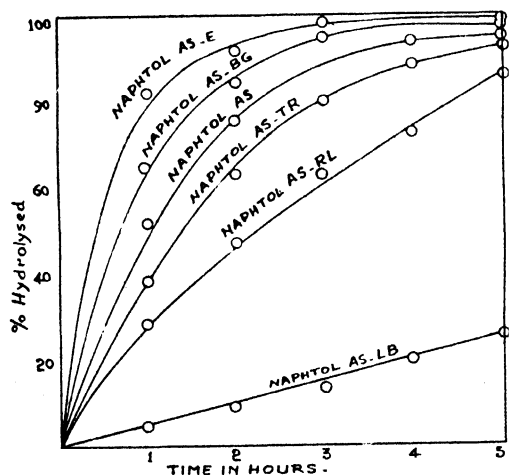


Fig. 2.—Hydrolysis of Naphtols with 25% Alcoholic KOH.

Hydrolysis of Naphtols AS-RL, AS-TR, AS-OL, AS-BG, AS-E and AS-LB was similarly studied using 25, 20 and 15 per cent. alcoholic potash. The results obtained are summarized in Tables VII—IX. (Results of Naphtol AS are included for comparison.) The results are graphically represented in Figs. 1 and 2.

TABLE III. *Effect of dilution of alcohol (alkali strength remaining constant, 20 per cent.) on the hydrolysis of Naphtol AS.*

Weight of naphtol, gms.	0.2480	0.2505	0.2513	0.2488	0.2514	0.2499
Alcoholic KOH added, cc.	10	10	10	10	10	10
Strength of alcohol, %	99.5	95	90	85	80	75
Duration of heating, hrs.	1.5	1.5	1.5	1.5	1.5	1.5
Weight of precipitate, gms.	0.1389	0.1560	0.1733	0.2033	0.2172	0.2280
Unhydrolysed naphtol, %	56.0	62.3	69.0	81.7	86.5	91.2
Hydrolysed naphtol, %	44.0	37.7	31.0	18.3	13.5	8.8

TABLE IV. *Hydrolysis of Naphtol AS with 25 per cent. alcoholic potash (alcohol 99.5 per cent.)*

Weight of naphtol, gms.	0.2495	0.2497	0.2498	0.2472	0.2475
Alcoholic KOH added, cc.	10	10	10	10	10
Duration of heating, hrs.	1	2	3	4	5
Weight of precipitate, gms.	0.1200	0.0590	0.0271	0.0111	0.0095
Unhydrolysed naphtol, %	48.1	23.6	10.8	4.5	3.8
Hydrolysed naphtol, %	51.9	76.4	89.2	95.5	96.2

TABLE V. *Hydrolysis of Naphtol AS with 20 per cent. alcoholic potash (alcohol 99.5 per cent.)*

Weight of naphtol, gms.	0.2495	0.2502	0.2492	0.2492	0.2475
Alcoholic KOH added, cc.	10	10	10	10	10
Duration of heating, hrs.	1	2	3	4	5
Weight of precipitate, gms.	0.1696	0.1175	0.0739	0.0555	0.0350
Unhydrolysed naphtol, %	68.0	47.0	29.6	22.3	14.1
Hydrolysed naphtol, %	32.0	53.0	70.4	77.7	86.9

TABLE VI. *Hydrolysis of Naphtol AS with 15 per cent. alcoholic potash (alcohol 99.5 per cent.)*

Weight of naphtol, gms.	0.2519	0.2511	0.2503	0.2510	0.2506
Alcoholic KOH added, cc.	10	10	10	10	10
Duration of heating, hrs.	1	2	3	4	5
Weight of precipitate, gms.	0.2356	0.2129	0.1907	0.1773	0.1621
Unhydrolysed naphtol, %	93.5	84.8	76.2	70.7	64.7
Hydrolysed naphtol, %	6.5	15.2	23.8	29.3	35.3

TABLE VII. *Hydrolysis of Naphtols with 25 per cent. alcoholic potash.*

Duration of heating, hrs.	1	2	3	4	5
Naphtol AS hydrolysed, %	51.9	76.4	89.2	95.5	96.2
" AS-RL "	28.8	48.7	63.8	75.5	87.1
" AS-TR "	39.5	64.6	80.3	90.6	94.2
" AS-BG "	65.7	85.2	96.1	99.6	99.8
" AS-E "	82.2	93.0	99.0	99.6	99.8
" AS-LB "	5.1	10.2	14.9	21.8	27.3

TABLE VIII. *Hydrolysis of Naphtols with 20 per cent. alcoholic potash.*

Duration of heating, hrs.	1	2	3	4	5
Naphtol AS hydrolysed, %	32.0	53.0	70.4	77.7	86.9
" AS-RL "	13.5	27.5	39.5	47.7	55.4
" AS-TR "	26.5	46.8	65.6	77.7	81.2
" AS-OL "	37.2	65.5	80.6	89.3	92.7
" AS-BG "	41.8	74.3	90.1	95.2	98.2
" AS-E "	53.5	76.1	94.5	98.5	98.7
" AS-LB "	1.8	4.8	6.6	10.7	11.0

TABLE IX. *Hydrolysis of Naphtols with 15 per cent. alcoholic potash.*

Duration of heating, hrs.	1	2	3	4	5
Naphtol AS hydrolysed, %	6.5	15.2	23.8	29.3	35.3
" AS-RL "	3.9	7.0	10.5	15.0	17.0
" AS-TR "	8.5	16.4	25.7	34.4	36.1
" AS-OL "	12.4	23.4	31.5	43.4	46.9
" AS-BG "	18.5	33.8	46.1	60.6	63.9
" AS-E "	17.4	32.9	47.9	58.8	63.9
" AS-LB "	1.3	2.1	2.8	4.8	4.3

Conclusions

1. Hydrolysis does not take place at ordinary room temperatures (Table I).

2. Hydrolysis is the function of the strength of the alkali solution and time, and is independent of the total quantity of alkali added as long as this quantity is in excess of that theoretically required for hydrolysis (Table II).

3. Hydrolysis is a function of the strength of alcohol in the alkali solution (Table III).

4. The strength of alkali remaining constant, different naphthols are hydrolysed to different extents in the same amount of time. It seems that in the case of naphthols

derived from hydroxy-carazol-carboxylic acid, the hydrolysis is slow although the solubility of naphthol in alcohol is comparatively good (Tables VII, VIII, IX).

References

¹ Rowe, *J. Soc. Dyers and Col.*, 1930, **46**, 227; Rowe and Levin, *Ibid.*, 1924, **40**, 227; 1926, **42**, 82.

² Rowe and Gibbs, *J. Soc. Dyers and Col.*, 1935, **51**, 287.

³ Ueno and Suzuki, *J. Soc. Chem. Ind., Japan*, 1934, **37**, 233B; *J. Soc. Dyers and Col.*, 1934, **50**, 264.

⁴ Desai and Mehta, *J. Soc. Dyers and Col.*, 1938, **54**, 422.

⁵ Hopper, MacGregor and Wilson, *J. Soc. Dyers and Col.*, 1939, **55**, 449.

COKE STRENGTH DETERMINATIONS IN CARBON ELECTRODE MANUFACTURE

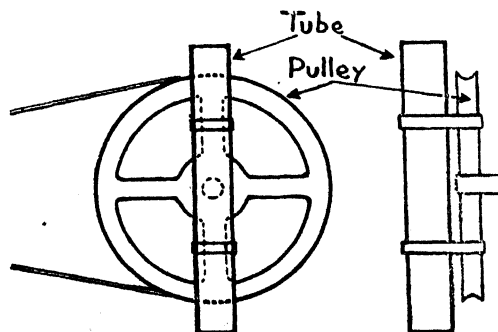
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DURING investigational work¹ on the manufacture of carbon electrodes, it was noticed that the mechanical strength of the electrodes depended to a considerable extent on the inherent mechanical strength of the body materials that were used in their manufacture. The strength of coals and cokes of different origin are known to vary considerably. The strength is generally determined by the shatter test or by the Cochrane abrasion test, and is given as the shatter-index or the Cochrane abrasion index. These tests require large samples, and are not convenient for laboratory experimental conditions. The apparatus designed by the Northern Coke Research Committee (N.C.R.C.)^{2,3} is compact and better adapted for laboratory working conditions, the quantity of material required being very small. It is stated² that the micro-strength index determined with this apparatus bears no simple relation to the shatter index or the Cochrane abrasion index. It gives a much more fundamental measure of the strength of the coke substance than either of these tests, the results of which are influenced largely by the amount of fissuring which has occurred in the coke.

To determine the strength of the body materials and of the baked electrodes, an apparatus similar to that of N.C.R.C. was built up. The working conditions were, however, slightly altered to suit the equipment available.

The apparatus was made out of a steel tube closed at each end by flat screwed caps. The inside dimensions of the closed tube were 12" long and 1" diameter. The tube was centrally mounted on one face of a pulley with the axis parallel to the face, and rotated at a constant speed about a central axis at right angles to the length of the tube.



In carrying out the test, 5 gms. of the material graded between 30- and 50-mesh (Tyler) sieves, was placed in the tube together with 12 hard steel balls of 0.25" diameter. The tube was then closed and rotated for 1,000 revolutions, the speed being adjusted so as to complete the test in 30 minutes. After 1,000 revolutions, the material was taken out and sieved through 50- and 100-mesh (Tyler) sieves. The results obtained with different varieties of cokes and baked electrodes are given in Table I. The figures which are reproducible, represent the average of three or more tests, and is the percentage of the coke, which after sieving remains on 50- and 100-mesh (Tyler) sieves.

TABLE I. *Micro-Strength Indices.*

No.	Material	Abrasion Index. Percentage retained on	
		50 mesh	100 mesh
1.	Retort carbon	54.0	32.9
2.	Projector arc carbon—negative rods	52.4	28.3
3.	Projector arc carbon—positive rods	46.5	31.9
4.	Dry cell carbon rods	46.3	28.5
5.	Foundry coke	46.0	37.8
6.	Furnace electrode	44.1	33.0
7.	Calcined petroleum coke,—2nd lot slowly calcined	43.8	35.7
8.	Lab. made carbon rods	40.0	36.5
9.	Calcined petroleum coke,—1st lot	39.8	36.6
10.	Steam coal	24.3	41.3
11.	Uncalcined petroleum coke	3.8	38.5
A.	Charcoal, wet	50.7	32.5
B.	Charcoal, dry	40.1	37.8

It will be seen from the table that among the samples tested, retort carbon tops the list in strength. Then come the various arc electrodes for projection work and dry cell rods of a well-known imported make. Foundry coke, furnace electrode, etc., follow in order of strength. The difference in strength between the calcined and the uncalcined samples is quite noticeable.

In the manufacture of carbon electrodes retort carbon, anthracite coal and petroleum coke are mostly used as body materials. The last two materials are generally calcined before use, at about 1,200° C. to drive off the volatile matter and obtain an improved product.

These materials contain binding constituents which during calcination pass through different stages and affect the bonding of the residue. It is considered² that the mechanical pressure due to gas evolution during calcination brings the crystallites into closer contact and thus promotes increase of mechanical strength. The particle size of the material also influences the strength.

The process of calcination brings about considerable changes^{4,5} in the constitution of the material as well as in its physical, mechanical and electrical characteristics. The variations in these characteristics depend upon the process of calcination. The final temperature reached during calcination, and the length of time taken to reach this, as well as the soaking time at the final temperature, considerably affect these characteristics.

In the process of baking of carbon electrodes, made from retort carbon, anthracite coal and petroleum coke as body materials and coal tar pitch and tar as binding materials, the temperature is raised very slowly under close control and this naturally gives the baked rods a high mechanical strength. During the calcination process, however, it is not possible to have a similar close control, and also to carry out the calcination as slowly as is done for the baking of electrodes. This leads to a product of varying quality. To overcome this to a certain extent, and to maintain a uniform product, it is the practice with electrode manufacturers to admix a certain quantity of rejected baked rods, with the new batch every time.

It will, therefore, be seen that in the manufacture of carbon electrodes, great care should be taken in the proper selection of body materials, and a close control should also be maintained in the process of calcination and baking. The N.C.R.C. apparatus could be conveniently used for maintaining control on these variable factors as illustrated by tests described.

In Table I similar indices for charcoal wet and dry (A and B) are given. This method may prove useful in determining the strength of charcoal under laboratory conditions in place of the shatter test usually specified for the purpose. This might have immediate application in the selection of charcoal for producer-gas plants, work on which is in progress in different laboratories in the country.

References

- 1 Joglekar, G. D., Sen, D. and Verman, L. C., *J. Sci. Ind. Res.*, 1944, 2, 291.
- 2 Northern Coke Research Committee, Annual Report, 1937, 16, 148.
- 3 Baird and Tatlock, Ltd., *J. Sci. Inst.*, 1938, 15, 376.
- 4 Berry, A. G. V. and Edgeworth-Johnstone, R., *Ind. Eng. Chem.*, 1944, 36, 1140.
- 5 Berry, A. G. V. and Edgeworth-Johnstone, R., *Ind. Eng. Chem.*, 1945, 37, 551.

CHEMICAL INVESTIGATIONS ON THE ADRENAL GLANDS

PART I—THE ADRENALINE CONTENT OF THE SUPRARENAL GLANDS

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IN the course of our investigations on the large-scale production of adrenaline from adrenal glands from Indian slaughter-houses, it was essential at the outset to have a quantitative idea of the adrenaline content of the glands. A reference to published literature would show that there is wide variation in the values for the adrenaline content of glands, reported from different laboratories using different methods of assay (see Table I). The variations cannot possibly be attributed entirely to the difference in the adrenaline content of the glands experimented upon by the different authors.

TABLE I. Adrenaline Content of Ox Suprarenal Glands. (mg./gm. tissue)

Author and method	Whole gland	Medulla	Cortex
Folin, <i>et al.</i> , Uric acid reagent ¹	3.96	..	..
Barker, <i>et al.</i> , Persulphate method ²	3.3	9.0	2.0
Euler, Iodine oxidation method ⁷	..	13.5 to 14.7	..
Schild—			
(a) Folin's method ³	..	5.12	..
(b) Persulphate method	..	5.4	..
(c) Iodine method	..	5.68 8.43	..
Rees—			
(a) Folin's method ³ (Vitamin C absent)	3.4	..	..
(b) Persulphate method	3.2	..	..
Devine (1936), Iodine method ⁴	..	11.0 11.3	0.77 0.71
Devine (1937) ⁸			
(a) Corrected Folin	..	8.8 to 11.8	0.37 to 0.47
(b) Iodine method	..	8.9 to 12.2	0.36 to 0.43

It was, therefore, considered essential to investigate the relative merits of the different methods employed in the estimation of adrenaline. Three of the more important colorimetric methods were selected. These are:

(i) Folin's uric acid reagent method, (ii) Ewin's persulphate oxidation method, and (iii) Vulpian's iodine oxidation method. Folin's method is based upon the develop-

ment of a blue colour by the reduction of the uric acid reagent by adrenaline, whereas both the persulphate and the iodine methods are dependent upon the production of a characteristic red pigment by the oxidation of adrenaline. It is generally recognized that whilst Folin's method is remarkably *sensitive* and the blue colour can be easily and accurately matched against the standard in an ordinary Duboscq colorimeter, the persulphate and the iodine oxidation methods have to be preferred on account of their *specificity* (in spite of the composite nature of the resulting colour), especially when the estimations have to be carried out, not on pure adrenaline solutions, but on gland extracts, which contain besides adrenaline also other reducing agents. As a rule Folin's method of estimation gives higher values, whereas the two oxidation reagents yield values which are more in conformity with the biologically determined values.

(i) *Folin's Method.*—This method will be fully discussed in a subsequent part of this series. The uric acid reagent employed was that of Folin, Cannon and Denis¹; 20 per cent. sodium carbonate was added for the colour development; pure adrenaline was employed as the standard.

(ii) *The Persulphate Oxidation Method.*—According to this method², gland extracts are treated with persulphate reagent at pH. 5.4 and the maximum colour intensity attained at the end of 30 minutes, is evaluated by a tintometer. Schild³ observed that the colour development was extremely slow in the case of gland extracts, so that direct comparison against standard adrenaline solution in a colorimeter was practically ruled out: reliable results were obtained by reading off the maximum red tinge with the aid of a tintometer. Devine⁴ found that ox adrenals developed the maximum colour at the end of 2½ hours, whilst horse adrenals required nearly 6 hours. Rees⁵ showed that reliable results could be obtained using a

tintometer and by a proper adjustment of pH. (3.6 to 4.0) and temperature (37° C).

Our observations show that while standard adrenaline solution developed the maximum colour intensity within 15 minutes, the gland extracts attained the maxima only at the end of 2 to 2½ hours, at pH. 4 and at 37° C. The colour comparisons were made in the ordinary Duboscq colorimeter by the technique reported previously.⁶

(iii) *The Iodine Oxidation Method.*—Euler⁷ employed the iodine method for the estimation (spectrophotometric) of adrenaline in ox medulla: the values obtained compared favourably with those obtained by the biological method. Euler's observations were confirmed by Schild³ who also made use of the iodine oxidation method in a slightly modified form. In contrast to the Folin and the persulphate oxidation methods, the rate of colour development in the iodine test appears to be unaffected by traces of heavy metals. Devine⁸ pointed out that the Vulpian reaction while being more specific than Folin's, is likewise of a limited value as various compounds structurally related to adrenaline give rise to a red colour. However, in fresh gland extracts these interfering substances are not likely to be present. The iodine oxidation method was critically examined also by D'Silva⁹. The experience of the present authors has been that the iodine oxidation method gives reliable and easily reproducible results, and should be the method of choice where rapid estimations have to be carried out on gland extracts. The technique adopted by us was the modified method of Weller^{10,11}.

The colorimetric estimations were all carried out on 5 per cent. trichloroacetic acid extracts of fresh adrenal glands. In order that accurate comparisons could be drawn, simultaneous estimations were carried out with the three different methods on the same extracts. In the following table (Table II) are represented typical values for the adrenaline content of cattle and sheep, both for the whole glands as well as for the dissected cortex and medulla.

It will be seen that the values for the adrenaline content as estimated by the Folin's method are considerably higher than those obtained by the persulphate and iodine oxidation methods. As will be shown in the second part of this series, the results by

Folin's method are vitiated to a great extent by the presence in the adrenal gland in appreciable concentration of extraneous reducing agents. Greater reliance should, therefore, be placed on the results obtained by the two oxidation reagents which yield practically identical values. The actual yield of adrenaline obtained by us by processing adrenal glands (the yield of adrenaline from the glands is claimed to be fairly quantitative¹²) also agrees with the lower values obtained by the persulphate and the iodine reagents.

TABLE II. *Adrenaline Content of the Suprarenal Glands of Indian Animals.*

(mg. adrenaline per gm. of tissue)

	Folin's method	Persulphate method	Iodine method
<i>Cattle Adrenals—</i>			
1. Whole gland	3.06 3.00 2.94 3.20	1.87 1.82 1.82 1.86	1.89 1.80 1.91 1.88
av.	3.05	1.84	1.87
2. Medulla	5.78 6.64 6.08	4.41 4.74 4.80	4.79 4.76 4.94
av.	6.17	4.65	4.83
3. Cortex	1.34 1.25 1.12	0.39 0.36 0.27	0.32 0.28 0.42
av.	1.24	0.34	0.37
<i>Sheep Adrenals—</i>			
1. Whole gland	2.68 2.54 2.49 2.62	1.65 1.56 1.55 1.58	1.70 1.62 1.57 1.59
av.	2.58	1.59	1.62
2. Medulla	6.37 6.41 6.74	5.53 5.57 5.46	5.18 5.42 5.93
av.	6.51	5.52	5.51
3. Cortex	1.12 1.19 1.19	0.30 0.35 0.28	0.30 0.33 0.38
av.	1.17	0.31	0.34

A certain proportion of the total adrenaline (about 15 per cent.) is found in the adrenal cortex: this may be explained as due partly to post-mortem diffusion from the medullary tissue and partly to the impossibility of effecting an absolutely clean separation of the two tissues by dissection.

It will be noted that the adrenal glands obtained locally have a low adrenaline content as compared with glands available from the

packing houses of America and the abattoirs of Europe, a fact which should be attributed to the state of undernutrition of the animals selected for slaughter, and to the method of slaughter as practised in the Indian slaughter houses¹³.

Our thanks are due to the *Council of Scientific and Industrial Research* for financing this research.

References

¹ Folin, Cannon and Denis, *J. Biol. Chem.*, 1912-13, **13**, 477.

² Barker, Eastland and Evers, *Biochem. J.*, 1932, **26**, 2129.

³ Schild, *J. Physiol.*, 1933, **79**, 455.

⁴ Devine, *Biochem. J.*, 1936, **30**, 1768.

⁵ Rees, *Quart. J. Pharm. and Pharmacol.*, 1936, **9**, 659.

⁶ Dey, Krishnan and Sreenivasan, *Curr. Sci.*, 1944, **13**, 67.

⁷ Euler, *Biochem. Z.*, 1933, **260**, 18.

⁸ Devine, *Biochem. J.*, 1937, **31**, 545; 1940, **34**, 21.

⁹ D'Silva, *Biochem. J.*, 1937, **31**, 2171.

¹⁰ Weller, *Bull. Soc. Chim. Biol.*, 1933, **15**, 1308.

¹¹ Binet and Weller, *Compt. rend. Soc. Biol.*, 1934, **115**, 598.

¹² Barger, *Organic Chemistry in Biology and Medicine*, 1930.

¹³ Dey, *Curr. Sci.*, 1942, **11**, 419.

¹⁴ Hussain and Sreenivasaya, *J. Sci. & Ind. Res.*, 1945, **3**, 445.

CHEMICAL INVESTIGATIONS ON THE ADRENAL GLANDS

PART 2—FOLIN'S COLORIMETRIC METHOD FOR THE ESTIMATION OF ADRENALINE IN SUPRARENAL GLAND EXTRACTS

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THE phosphotungstic acid reagent of Folin and Denis¹ for the estimation of uric acid was applied by Folin, Cannon and Denis² for the quantitative colorimetric determination of adrenaline in gland extracts. The procedure consists in extracting the gland material by boiling hydrochloric acid (dil.), deproteinizing in the hot, adding the uric acid reagent and alkali to the filtrate and then matching the colour against standard uric acid. The presence of interfering reducing substances in the gland material seriously affect the results obtained by this method. Stewart and Rogoff³, however, report that estimations carried out in neutral extracts with Folin's reagent gave values agreeing closely with those obtained by the pressor assay method.

Baker and Marrian⁴ pointed out that a small but definite loss of adrenaline (due to oxidative decomposition) takes place when the deproteinization is carried out in the hot by the addition of sodium acetate; they recommended the extraction of the gland

material in the cold with trichloroacetic acid. Although it was pointed out (*cf.* D'Silva⁵ and Shaw⁶) that trichloroacetic acid precipitation of proteins leads to a loss of adrenaline in the filtrate, the method has been widely adopted. Euler⁷ and Schild⁸ showed that deproteinization could be carried out in the hot without loss of adrenaline. The development of colour is influenced by the pH. (Barker, Eastland and Evers⁹, Rees¹⁰) and the temperature.

Based on a critical study of the colour development¹¹⁻¹³, Folin, *et al.*, suggested a modified reagent¹⁴ for the estimation of adrenaline. The reagent, however, is non-specific. Lewis¹⁵, Maiweg¹⁶, Frowein¹⁷, Watanabe and Sato¹⁸, and Barker, Eastland and Evers⁹ report high values by the application of this method, while Sydenstricker *et al.*¹⁹, Schild²⁰ and Devine²¹ obtained low values.

Among the interfering substances present in the adrenal glands, the most important

is ascorbic acid^{21,22,23} which is present both in the medulla and in the cortex. Rees¹⁰ suggested that ascorbic acid oxidase could be used for destroying the acid before adding the Folin reagent. Silicic acid²⁴ and aluminium hydroxide have been suggested as selective absorbents for adrenaline, but these methods have not met with general application. Borsook, *et al.*²⁵ reported that relatively large quantities of a reducing substance, other than ascorbic acid, was present in the guinea-pig adrenals. The experiments of Devine²⁶ show that certain unidentified catechol compounds were present in the adrenal cortex: these, however, do not react with the modified uric acid reagent²¹. Kendall²⁷ mentions the existence in the adrenal gland of a lactic acid derivative of adrenaline—lactyl epinephrine—which reduces Folin's reagent. Uric acid is also present in small quantities in the glands^{15,8,26,21} and sulphhydryl compounds which are present, also interfere with the method²⁸.

It was suggested by Rees¹⁰ that satisfactory estimations of adrenaline in gland extracts could be carried out with Folin's reagent, provided suitable correction is made for the ascorbic acid which can be independently estimated by the indophenol reagent. Devine²¹ showed that in the case of medullary extracts, the values obtained by Folin's method after correcting for ascorbic acid agree closely with those obtained by the iodine oxidation method and the biological method; in the case of cortical extract, however, the agreement was less satisfactory, the corrected Folin's values being about 30 per cent. higher: this was attributed to the formation of secondary oxidation products of ascorbic acid, which though not titratable with indophenol reagent, still reduce the uric acid reagent giving a blue colour. The error due to uric acid was about 5 per cent. of that due to ascorbic acid. Using phosphoric acid extracts of cortical tissue under conditions which would minimize the oxidation of ascorbic acid, Devine obtained values which agreed closely with those obtained by the iodine oxidation method. It has since been shown that under the conditions adopted by Devine, partial oxidation of ascorbic acid and probably of other reducing materials, do indeed occur. Devine found that medullary extracts contained 0.58 to 0.75 mg. of ascorbic acid per gm. of fresh tissue, and cortical extracts 0.68 to 0.72 mg. The actual values reported in the

literature are 1.1 to 1.2 and 1.62 mg. respectively^{29,30}.

Investigations carried out in these laboratories on the reducing systems present in the adrenal glands indicate that the apparent adrenaline content as obtained by Folin's method could not be satisfactorily corrected by making allowance for ascorbic acid, and that other powerful reducing substances are present in appreciable concentrations in the fresh glands. A detailed investigation of the colour reaction of adrenal gland extracts with Folin's uric acid reagent was undertaken, and the results obtained are reported in this paper.

Experimental

The glands were extracted in the cold with 5 per cent. trichloroacetic acid, using a glass mortar and pestle and acid-washed sand for rapidly disintegrating the tissue material (care was taken to minimize exposure to air). Starting with two glands weighing 12 to 18 gms., the final extract was made up to 100 cc. The estimations described below were carried out simultaneously on the same material immediately after extraction: when this was not possible, the extracts were stored in a refrigerator and the estimations completed in one to two hours.

(i) *Depth of Colour and the Nature of Alkali*.—Folin, Cannon and Denis² used saturated sodium carbonate for rendering the extract alkaline. Benedict³¹ employed a 20 per cent. solution of anhydrous sodium carbonate, and Barker *et al.*⁹ used sodium hydroxide in slight excess of the calculated quantity.

Simultaneous estimations of the adrenaline content of fresh extracts were carried out using as alkalinizing agent (a) sodium carbonate solution saturated at the laboratory temperature (about 40 per cent.), (b) 20 per cent. sodium carbonate solution and (c) 5 per cent. sodium hydroxide in slight excess of the calculated quantity. Folin, Cannon and Denis uric acid reagent was employed. The pH. was in all cases distinctly alkaline to thymolphthalein. The results obtained are given in Table I.

TABLE I. *Influence of Alkali on Depth of Colour*

Alkali	Adrenaline content (mg. per gm. of gland)
(a) Sodium carbonate, saturated at room temperature	2.84
(b) 20 per cent. sodium carbonate	2.86
(c) 5 per cent. sodium hydroxide	2.84

Identical depths of colour were obtained with the different alkalis. It was apparent, therefore, that the original direction of Folin *et al.*, as modified by Benedict by using 20 per cent. sodium carbonate, yields accurate results and that no special advantage is gained by using sodium hydroxide.

(ii) *Uric Acid Reagents*.—Starting with a specimen of commercial sodium tungstate which gave a faint but distinct colour reaction for molybdenum with xanthate reagent, the following five reagents were prepared according to the directions given by the respective authors:

- (a) Folin-Cannon-Denis reagent².
- (b) Folin-Trimble reagent¹¹.
- (c) Folin-Marenzi reagent¹².
- (d) Folin's reagent¹³.
- (e) Folin's reagent¹⁴.

Simultaneous estimations of the adrenaline content of a given extract using the five different reagents were carried out, using 20 per cent. sodium carbonate as alkali. The results obtained with one of the extracts are given in Table II.

TABLE II. *Colour Intensity with Different Uric Acid Reagents*

Reagent	Adrenaline content (mg. per gm. of gland)
(a) Folin-Cannon-Denis	3.05
(b) Folin-Trimble	3.10
(c) Folin-Marenzi	3.08
(d) Folin (1933)	3.02
(e) Folin (1934)	3.02

It is clear that the different reagents give the same depth of colour with a given extract. Similar results were obtained with pure adrenaline solutions. The different uric acid reagents are, therefore, quantitatively equivalent to one another.

(iii) *Corrections for (a) Ascorbic Acid, (b) Uric Acid, and (c) Glutathione*.—(a) *Ascorbic Acid*.—Ascorbic acid estimations were carried out with 5 per cent. trichloroacetic acid extracts by titration^{32, 33} with 2:6 dibromophenol indophenol (Table III). Simultaneous estimations were carried out on gland extracts made with metaphosphoric acid (3 per cent.)³⁴ and with a mixture of metaphosphoric acid (2 per cent.) and trichloroacetic acid (8 per cent.)³⁵; since these three sets of figures agree with each other within the limits of experimental error, it is clear that the extraction of the vitamin by 5 per cent. trichloroacetic acid is complete and

that no secondary oxidation takes place during extraction. Titrations carried out on the filtrates obtained after removal of interfering material by the Emmerie-van Eekelen technique³⁶ show good correspondence with the titration figures before precipitation, so that it can be concluded that the values obtained by direct titration using a 5 per cent. trichloroacetic acid extract of gland material, gives a correct estimate of the ascorbic acid content.

Table IV gives the corrections to be applied for the presence of ascorbic acid. The factor 0.375 (Devine²¹) for the ascorbic acid-adrenaline colour ratio is made use of in these calculations.

It will be apparent from the table that the ascorbic acid in the whole gland will contribute 11-19 per cent. of the total colour due to Folin's reagent.

(b) *Uric Acid*.—The method of Folin¹³ in which the uric acid is precipitated as silver salt, precipitate decomposed with acidified sodium chloride and the uric acid in the filtrate utilized for the estimation, was employed. Separate estimations carried out on the whole silver precipitate by dissolving in cyanide solution and developing the colour, yielded values which agreed closely with those obtained by the extraction procedure; also, when the silver residue left after extraction, was dissolved in cyanide solution and treated with the reagent, no blue colour was obtained. It is clear from this that interfering materials like ergothionine and glutathione do not contaminate the silver urate precipitate. The values for uric acid and the corrections for the same in the estimation of adrenaline (factor, 1:3) are given in Table V. Uric acid, in the amounts present in the trichloroacetic acid extracts of the whole gland or of the dissected cortex and medulla, does not significantly affect the values for adrenaline.

(c) *Glutathione*.—A correction factor for reduced glutathione present cannot be worked out as in the case of ascorbic acid and uric acid. It has been shown by Shinohara and Padis³⁷ that the colour reaction of glutathione with uric acid reagent is not proportional to the concentration of the former. The direct determination of glutathione in the glands would therefore have no significance. By precipitating glutathione from trichloroacetic acid extracts with

TABLE III. *Ascorbic Acid Content of Adrenal Glands.*
(mg. per gm. of gland)

Glands from	Direct titration on whole extract.			Titration on filtrate after mercuric acetate precipitation
	Trichlor-acetic acid	Metaphosphoric acid	Metaphosphoric acid plus trichlor-acetic acid	
Cattle	0.90	0.94	0.94	0.89
Sheep	1.30	1.35	1.34	1.29

TABLE IV. *Folin's Values Corrected for Ascorbic Acid.*

Gland material	Ascorbic acid (mg./gm. of tissue)	Adrenaline equivalent of ascorbic acid	Apparent Adrenaline as estimated by Folin's reagent	% of total Folin's colour due to ascorbic acid
<i>Cattle—</i>				
(a) Whole gland	0.91	0.34	3.05	11.2
(b) Medulla	0.93	0.35	6.17	5.7
(c) Cortex	0.96	0.36	1.24	29.0
<i>Sheep—</i>				
(a) Whole gland	1.30	0.49	2.54	19.3
(b) Medulla	0.99	0.37	6.50	5.7
(c) Cortex	1.45	0.54	1.17	46.2

TABLE V. *Uric Acid in Adrenal Glands*

Gland material	Uric acid mg./gm. of tissue	Adrenaline equivalent of uric acid	Apparent adrenaline as estimated by Folin's reagent	% of total Folin's colour due to uric acid
<i>Cattle—</i>				
(i) Whole gland	0.092	0.031	3.05	1.0
(ii) Medulla	0.127	0.042	6.17	0.7
(iii) Cortex	0.053	0.018	1.24	1.5
<i>Sheep—</i>				
(i) Whole gland	0.088	0.029	2.54	1.1
(ii) Medulla	0.098	0.033	6.50	0.5
(iii) Cortex	0.072	0.024	1.17	2.0

TABLE VI. *Correction for Reduced Glutathione in Gland Extracts.*

Gland material	Adrenaline equivalent of GSH. (mg./gm. tissue)	Apparent Adrenaline as estimated with Folin's reagent	% of total Folin's colour due to GSH.
<i>Cattle adrenals—</i>			
(i) Whole gland	0.52	3.05	17.1
(ii) Medulla	0.66	6.17	10.7
(iii) Cortex	0.34	1.24	27.4
<i>Sheep adrenals—</i>			
(i) Whole gland	0.44	2.54	17.3
(ii) Medulla	0.76	6.50	11.7
(iii) Cortex	0.43	1.17	36.8

TABLE VII. *Adrenaline Content of Suprarenal Glands*
(mg./gm. of tissue)

	Apparent value	Folin's method—Correction for			Corrected Folin's value	Persulphate method	Iodine method
		uric acid	ascorbic acid	GSH			
<i>Cattle adrenals—</i>							
(i) Whole gland	3.05	0.03	0.34	0.52	2.16	1.84	1.87
(ii) Medulla	6.17	0.04	0.35	0.66	5.12	4.65	4.83
(iii) Cortex	1.24	0.02	0.36	0.34	0.52	0.34	0.37
<i>Sheep adrenals—</i>							
(i) Whole gland	2.54	0.03	0.49	0.44	1.58	1.59	1.62
(ii) Medulla	6.50	0.03	0.37	0.76	5.34	5.52	5.51
(iii) Cortex	1.17	0.02	0.54	0.43	0.18	0.31	0.34

cadmium lactate (Binet and Weller³⁸), dissolving the precipitate in trichloroacetic acid, developing the colour with the uric acid reagent and matching against the colour obtained with standard adrenaline and uric acid reagent, the adrenaline colour equivalent of glutathione can be calculated. Since duplicate estimations on the same extract gave identical values, and estimations carried out on different extracts yielded concordant values for the adrenaline equivalent of glutathione, it was apparent that such a correction factor would be valid. In Table VI are given the mean values obtained for the whole gland and for the dissected cortex and medulla.

The correction due to reduced glutathione amounts to about 17 per cent. in the whole gland, 11-12 per cent. in the dissected medulla and 27-37 per cent. in the cortex.

The combined corrections for ascorbic acid, uric acid and reduced glutathione are given in Table VII. The adrenaline content of the glands as estimated by the persulphate and iodine oxidation methods are also given for comparison. It will be evident from the table that when the Folin's values are corrected for ascorbic acid, uric acid and reduced glutathione, the net values agree with those obtained by the persulphate and iodine methods.

Summary

(i) Either sodium carbonate (in amounts specified by Benedict) or sodium hydroxide (as suggested by Barker, *et al.*) can be used for the development of colour with Folin's uric acid reagent; reproducible results are obtained in both the cases.

(ii) The five uric acid reagents described by Folin are all quantitatively equivalent to one another.

(iii) Folin's method is very unreliable when applied to gland extracts, the values obtained being high in the case of the whole gland extracts and especially with cortex extracts. The interference due to uric acid is negligible, but that due to ascorbic acid and glutathione is considerable. When suitable corrections are applied for the presence of ascorbic acid and glutathione, the

values obtained approximate to the figures obtained by the iodine and persulphate methods.

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References

- 1 Folin and Denis, *J. Biol. Chem.*, 1912, **12**, 239.
- 2 Folin, Cannon and Denis, *J. Biol. Chem.*, 1912-13, **13**, 477.
- 3 Stewart and Rogoff, *J. Exp. Med.*, 1916, **24**, 709.
- 4 Baker and Marrian, *Biochem. J.*, 1927, **21**, 1005.
- 5 D'Silva, *Biochem. J.*, 1937, **31**, 2171.
- 6 Shaw, *Biochem. J.*, 1938, **32**, 12.
- 7 Euler, *J. Physiol.*, 1933, **78**, 462.
- 8 Schild, *J. Physiol.*, 1933, **79**, 455.
- 9 Barker, Eastland and Evers, *Biochem. J.*, 1932, **26**, 2129.
- 10 Rees, *Quart. J. Pharm. Pharmacol.*, 1936, **9**, 659.
- 11 Folin and Trimble, *J. Biol. Chem.*, 1924, **60**, 473.
- 12 Folin and Maenzi, *J. Biol. Chem.*, 1929, **83**, 103.
- 13 Folin, *J. Biol. Chem.*, 1933, **101**, 111.
- 14 Folin, *J. Biol. Chem.*, 1934, **106**, 311.
- 15 Lewis, *J. Biol. Chem.*, 1916, **24**, 249.
- 16 Maiweg, *Biochem. Z.*, 1922, **134**, 292.
- 17 Frowein, *Biochem. Z.*, 1922, **134**, 559.
- 18 Watanabe and Sato, *Tohoku. J. Exp. Med.*, 1928, **11**, 410.
- 19 Sydenstricker, *et al.*, *J. Exp. Med.*, 1914, **19**, 539.
- 20 Schild, *J. Physiol.*, 1933, **79**, 455.
- 21 Devine, *Biochem. J.*, 1937, **31**, 545.
- 22 Guha, *Sci. and Cult.*, 1935, **1**, 111.
- 23 Kojima, *et al.*, *Tohoku. J. Exp. Med.*, 1932, **19**, 205.
- 24 Whitehorn, *J. Biol. Chem.*, 1935, **108**, 633.
- 25 Borsook *et al.*, *J. Biol. Chem.*, 1937, **117**, 237.
- 26 Devine, *Biochem. J.*, 1936, **30**, 1768.
- 27 Kendall, *J. Biol. Chem.*, 1932, **97**, 4.
- 28 Hunter and Eagles, *J. Biol. Chem.*, 1927, **72**, 177.
- 29 Harris and Ray, *Biochem. J.*, 1933, **27**, 2006.
- 30 Birch and Dann, *Nature*, 1933, **131**, 469.
- 31 Benedict and Hitchcock, *J. Biol. Chem.*, 1914, **20**, 619.
- 32 Bessey and King, *J. Biol. Chem.*, 1933, **103**, 687.
- 33 Birch, Harris and Ray, *Biochem. J.*, 1933, **27**, 590.
- 34 Musulin and King, *J. Biol. Chem.*, 1936, **116**, 409.
- 35 Bessey, *J. Biol. Chem.*, 1938, **126**, 771.
- 36 Emmerie and van Eekelen, *Biochem. J.*, 1934, **28**, 1153.
- 37 Shinohara and Padis, *J. Biol. Chem.*, 1935-36, **112**, 679.
- 38 Binet and Weller, *Bull. Soc., Chem. Biol.*, 1934, **16**, 1284.

POTASSIUM PERMANGANATE FROM FERRO-MANGANESE

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IT is known that permanganate can be obtained directly from manganese or ferro-manganese by anodic oxidation in an alkaline bath. Lorenz¹, Youtz², Wilson and Horsch employed anodic oxidation using a diaphragm-free cell, without much success. No satisfactory method was available for the conversion of ferro-manganese into permanganate on a commercial scale until 1941, when Antonie Lowy³ made a critical survey of the conditions necessary for successful results. Experimental work on the conversion of ferro-manganese to permanganate in the alkaline bath, with and without the use of diaphragm, has been carried out in our laboratories and the main conclusions obtained are in conformity with those of Lowy. Better yields are obtained in diaphragm cells, and even in diaphragm-free cells, high efficiencies can be realised.

Experimental

The ferro-manganese employed had the following percentage composition

Manganese	72.33
Iron	22.75
Silica	2.51
Carbon	2.41 (by diff.)

The ferro-manganese was supplied by Messrs. Tata Iron and Steel Co., and was in

the form of lumps of irregular sizes. The lumps were shaped into anodes of regular sizes and their areas measured. The anodes were suspended in a glass cell and connected to a D.C. supply through an ammeter and voltmeter. The cathode was of sheet iron. The electrolyte was a solution of sodium hydroxide of known strength. Diaphragms of unglazed porous pot were employed, and though they were quite satisfactory, repeated use caused disintegration.

The permanganate was estimated as active oxygen by the iodometric method of Lowy³. The results of the experiments are given in Tables I, II and III.

Discussion

Without the use of the diaphragm the maximum concentration of KMnO_4 found was 20.2 gms./litre after 5 hours, using 5.5N sodium hydroxide at a temperature of 29° C. In general, in the diaphragm-free cell, the yield of KMnO_4 was found to increase with decreasing temperature and increasing concentration of caustic soda. Decreasing the concentration of caustic soda to 4N, the yield of KMnO_4 at 28° C. with an anode current density of 0.144 amp./sq. cm. was only 4.0 gms./litre after 4.0 hours,

TABLE I. No diaphragm was used.

Volume of electrolyte=250 cc. ; Cathode area=38 sq. cms. ; Anode area=12.5 sq. cm.

Conditions	Time hrs.	KMnO ₄ produced gms./litre.	Theoretical yield gms./litre.	Current efficiency. %	NaOH added cc.
Current=1.4 amps. Potential=4.3 volts. Temp.=31° C. Anode C.D.=0.112 amp./sq. cm. NaOH=5.5 N.	1	0.75	4.72	15.9	....
	2	1.35	9.43	14.3	1.0
	3	2.00	14.15	14.1	....
	4	2.7	18.86	14.3	....
Current=1.85 amps. Potential=5 volts. Temp.=28° C. Anode C.D.=0.148 amp./sq. cm. NaOH=5.5 N.	1	4.00	5.98	66.9	....
	2	8.00	12.21	65.5	....
	3	11.90	18.44	64.4	....
	4	15.60	24.42	63.8	2.0
	5	20.20	30.64	65.5	....
Current=1.35 amps. Potential=5. volts. Temp.=29.5° Anode C.D.=0.112 amp./sq. cm. NaOH=4 N	1	1.10	4.72	23.4	....
	2	2.20	9.43	23.4	....
	3	3.20	13.81	23.4	5.0
	4	4.00	18.19	22.0	....
	5	4.40	22.57	19.52	....
Current=1.80 amps. Potential=5.5 volts. Temp.=28.5° C. Anode C.D.=0.144 amp./sq. cm. NaOH=4 N.	1	1.10	5.98	18.38	....
	2	2.20	11.97	18.4	5.0
	3	3.10	17.95	17.32	....
	4	4.00	23.94	16.72	....

TABLE II. Diaphragm of unglazed porcelain.
Vol. of the electrolyte=250. cc.; NaOH=5 N.

Conditions	Time hrs.	Theoretical yield in gms./litre.		KMnO ₄ produced gms./litre	Current efficiency %	NaOH soln added in cc.
		Mn→Mn ⁺	Mn→Mn ⁺			
Potential=5.5 volts	1	5.984	7.072	6.00	> 100.0	..
Current=1.9 amps.	2	12.208	14.340	12.00	> 100.0	..
Anode C.D.=0.15 amp. per sq.cm.	3	18.608	21.800	18.60	> 100.0	5
Temp.=15° C.	4	25.010	29.260	24.80	> 100.0	..
Anode area=12.5 sq. cm.	5	31.410	36.400	31.60	> 100.0	5
Cathode area=38 sq. cm.	6	37.810	43.860	38.50	> 100.0	..
Potential=6. volts	1	5.130	7.840	8.10	> 100.0	..
Current=2. amps.	2	13.470	15.680	16.20	> 100.0	5
Anode C.D.=0.16 amp. per sq.cm.	3	20.210	23.520	24.30	> 100.0	..
Temp.=10° C.	4	26.940	31.360	32.40	> 100.0	..
Anode area=12.5 sq.cm.	5	33.340	38.800	40.80	> 100.0	5
Cathode area=38.0 sq. cm.	6	42.680	46.080	49.00	> 100.0	..
Potential=6.8 volts	1	15.130	3.20	21.15	..	..
Current=4.4 amps.	2	30.260	6.40	21.15	..	..
Anode C.D.=0.14 amp. per sq.cm.	3	45.390	9.60	21.15	..	..
Anode area=30.0 sq.cm.	4	60.520	12.80	21.15	..	..
Cathode area=100.0 sq. cm.	6	90.260	19.00	21.30	5	..
Temp.=16° C.	8	119.900	24.80	20.70	..	..
	10	149.460	30.80	20.62	..	..
	12	179.180	36.50	20.38	5	..
	14	208.820	41.30	19.85	..	..
	16	238.130	46.30	19.48	..	..
	18	267.096	51.00	19.22	..	..

TABLE III. Porous Diaphragm used.

Vol. of electrolyte = 500 cc.; Anode area = 23. sq. cm.; Cathode area = 70 sq. cm.;
Current = 4.50 amps.; Anode C.D. = 0.19 amp./sq.cm.; Temperature = 10° C.; NaOH = 5 N.

Time hrs.	Potential volts.	Theoretical yield gms./litre.	KMnO ₄ produced gms./litre.	Current efficiency %	NaOH added in cc.
1	6.5	15.13	3.8	25.10	..
2	6.5	30.31	7.5	24.76	..
3	7.0	45.47	10.1	22.21	..
4	7.2	60.62	13.5	22.30	5 cc.
6	7.2	90.93	17.1	18.90	..
8	7.2	121.25	23.2	19.15	5 cc.
10	7.0	151.56	28.9	19.08	..
12	7.2	181.87	33.2	18.28	..

while with 5.5 N. caustic soda at 25° C. with a current density of 0.148 amp. per sq. cm. the yield was 20.20 gms./litre.

It is interesting to find that current efficiency goes on decreasing as the working period of the cell is increased. This is in agreement with Lowy's results. It is found that the maximum current efficiency of about 64 per cent. is realized in working the cell at 28° C. with an anode current density of 0.148 amp/sq. cm. The maximum current efficiency realized by Lowy was 34.6 per cent. under optimum conditions.

By the use of porous pot diaphragms, better current efficiencies can be realized with higher current density. With low voltages it is found that appreciable quantities of manganate is formed in solution as is evident from Table II, where current efficiency based on Mn→Mn⁺ is found to be above 100 per cent. while current efficiency calculated on Mn→Mn⁺ is of the order of 85 per cent. showing that both manganate and

permanganate are formed and the value for the calculation of current efficiency should be based on the manganate/permanganate ratio. The results in Table II show that even Mn→Mn⁺ gives an efficiency above 100 per cent. indicating that probably some lower compound of manganese which would give Mn→Mn⁺ or Mn→Mn⁺ was being formed, probably chlorides, which are usually associated with commercial caustic soda as an impurity.

Using a diaphragm cell, and working at 7 volts and 5 to 5.5 normal NaOH at a current density varying from 0.146 to 0.19 amp/sq. cm., it was seen that the current, efficiency does not decrease with increase in the working period of the cell.

Our thanks are due to Messrs. Tata Iron and Steel Co. for the supply of ferro-manganese.

References

- Lorenz, Z. anorg. Chem., 1896, 12, 393.
- Wilson, Horsch and Youtz, J. Ind. Eng. Chem., 1921, 13, 763.
- Lowy, Trans. Electrochem. Soc., 1941, 80, 63.

MANUFACTURE OF BARIUM CHLORIDE

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BARYTES, the only commercial raw material available in India for the manufacture of barium compounds, occurs in the South near Betamchelera in Kurnool District and Alangayam in Salem District. It occurs in Central India near the Mohan River and in Baluchistan near the Sun-mowli River and lower slopes of the Pab range.

A number of processes have been suggested for the preparation of barium chloride from barytes. The details for successful production, however, are not available. Shreve and Prichard¹ have published a series of papers on their studies on the decomposition of barium sulphate and strontium sulphate by calcium chloride in aqueous solutions and also in the fused state. They have obtained more than 90 per cent. conversion to barium chloride by both procedures. Organic solvents have been used for extraction, as in the aqueous medium reversion of barium chloride to sulphate takes place. For large-scale operation, the recovery of organic solvents presents a serious problem.

The reversion to sulphate during the extraction of the fused mass with water can be avoided if carbon is added during the fusion. In the presence of carbon, reduction of barium sulphate to sulphide takes place and the barium sulphide reacts with the calcium chloride. The calcium sulphide formed is practically insoluble in water (while the barium sulphide is easily soluble) and hence no reversion of the barium chloride to sulphide is possible. Thermal considerations also show that the reaction between barium sulphide and calcium chloride takes place at a faster rate than that between barium sulphate and calcium chloride, and this constitutes an additional advantage gained by using carbon.

It is possible to suggest a mechanism for the reaction between barium sulphide and calcium chloride on the basis of available data² relating to the binary system BaCl_2 — CaCl_2 . The reaction is one of equilibrium between the fused salt calcium chloride and barium sulphide. Calcium chloride melts at 773°C . and barium sulphide dissolves in the molten mass. Calcium sulphide being practi-

cally insoluble in the fused calcium chloride, it is thrown out of the system while the barium chloride goes into solution. The equilibrium follows the course of the curve in the system CaCl_2 — BaCl_2 (Fig. 1). As more and more barium chloride is formed, the melting point is lowered until the eutectic at 592°C . (36.7 mol. per cent. BaCl_2) is reached. Then the compound $\text{CaCl}_2 \cdot \text{BaCl}_2$ appears with a melting point of 631°C . This again forms an eutectic with 54 mol. per cent. BaCl_2 at 617°C . As more and more barium chloride is formed, the melting point increases and if the furnace is maintained at 800°C . the reaction stops after the fused salts have reached the composition 78 mol. per cent. BaCl_2 .

During this investigation it was observed that the reaction products melt slowly, become more and more fluid, but thicken again towards the end of the reaction. This can be explained by the melting point curve and is of special value in following the course of the reaction. In large-scale operations there is always a tendency to draw out the fused products at the first appearance of the molten mass and thus obtaining lower conversions.

Experimental

Finely powdered barytes, charcoal (100 mesh) and 50 per cent. calcium chloride (comm.) were intimately mixed and fused in fire-clay crucibles at 800 – 850°C . for 3–4 hours. The fused mass was extracted with water and the total amount of barium chloride in the extract estimated. The ratio between barium chloride and calcium chloride in the extract was also determined. The results obtained are shown in Table I.

From the results it is clear that when the carbon content is low, although enough calcium chloride is present the percentage conversion is only of the order of 50, similar to that obtained by direct fusion. This is probably because all the sulphate is not reduced and reversion is taking place while extracting the fused mass with water.

In all the cases, calcium chloride is present in the aqueous extracts. Its concentration increases with the initial amount of the

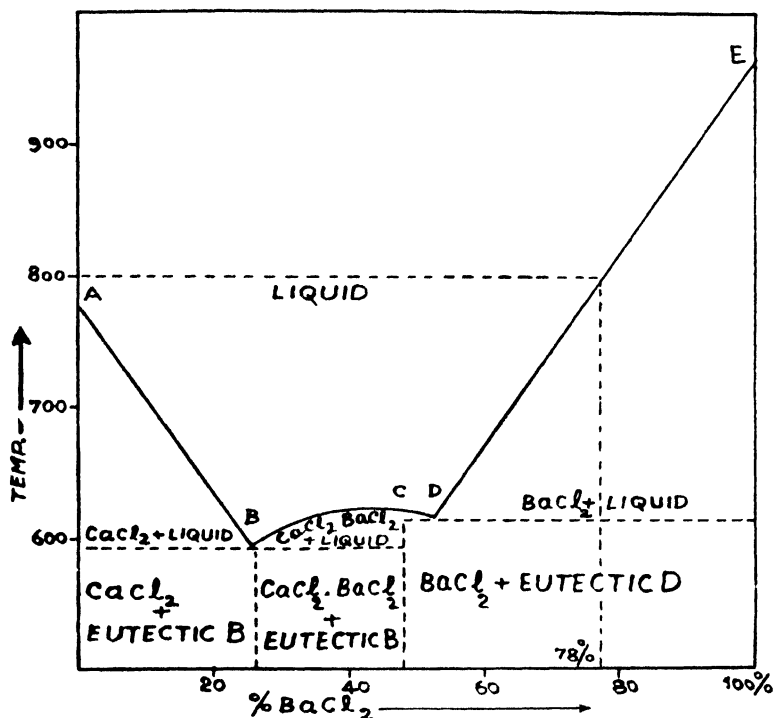


Fig. 1—Equilibrium Diagram for CaCl_2 - BaCl_2

chloride in the mixture when there is no carbon or when the carbon content is low. This is an important consideration, because the use of the water extract directly in brine purification* is only possible if its calcium chloride content is low. Satisfactory results are ensured when the proportion of calcium chloride (50 per cent.); barytes: charcoal=1.25: 0.5.

Manufacture

The process is being worked on a manufacturing scale at the *Mettur Chemicals Ltd., Mettur*. The sequence of the operations is indicated in Fig. 2. The coal-fired reverberatory furnace (1) is provided with three beds and heated to 300-850° C., a reducing atmosphere being maintained inside the furnace by controlling the air supply with the help of the damper.

Calcium chloride (50 per cent. solution), barytes and charcoal, the latter two being powdered to 100 mesh, are mixed together in the ratio 1.25: 1: 0.5, and charged into each of the three beds of the furnace at intervals of three hours. The completion of the reaction is determined by drawing out samples and estimating the conversion. By watching the fusion, an idea of the state of the reaction can be obtained as the reaction products pass through a stage of a mobile liquid and thicken again towards the end of the reaction.

The completion of the reaction usually takes about

* This is one of the main uses for barium chloride. Sulphate-free brine is required for alkali-chlorine cells.

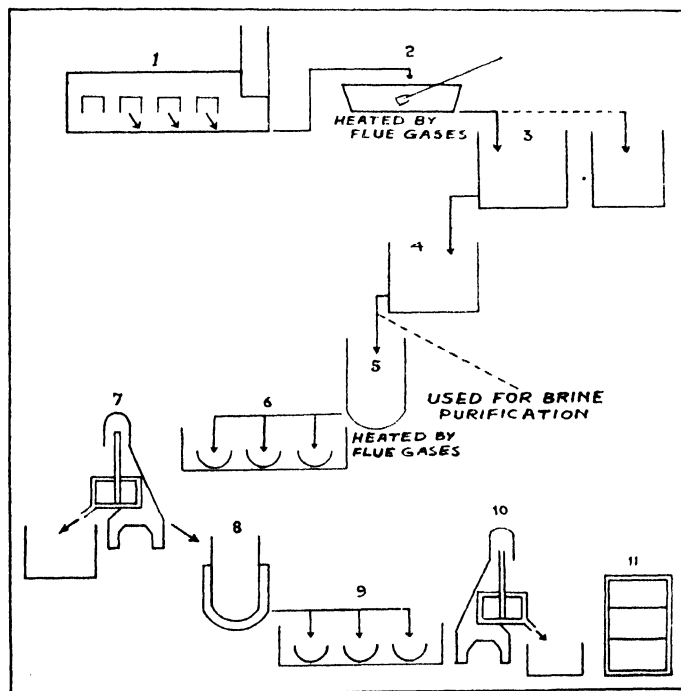


Fig. 2—Manufacture of Barium Chloride (Flowsheet)

TABLE I.

Calcium chloride 50% lbs.	Barytes lbs.	Charcoal powder lbs.	Conversion of barytes to barium chloride %	Ratio, CaCl ₂ : BaCl ₂ in extract
10.0	10	....	31.1	0.26
15.0	10	....	50.5	0.27
20.0	10	....	52.0	0.31
10.0	10	2.5	53.1	0.09
12.5	10	2.5	51.2	0.13
15.0	10	2.5	53.6	0.17
20.0	10	2.5	60.1	0.17
10.0	10	5.0	65.0	0.07
12.5	10	5.0	84.2	0.08
15.0	10	5.0	83.6	0.09
20.0	10	5.0	89.2	0.10
10.0	10	10.0	67.2	0.07
12.5	10	10.0	80.3	0.08
15.0	10	10.0	86.1	0.08
20.0	10	10.0	90.1	0.09

six hours. The reaction products are then drawn out and lixiviated in vats (2) which are heated by the flue gases of the furnace. As these gases contain carbon monoxide and other combustible gases, a special fire box is provided to set fire to them before they heat the lixiviation vats.

The reaction products are extracted thrice with water, the first two extracts varying in density between 18°-23° Be' which are sent to the first settling tank (3) while the third extract of 5°-9° Be' is transferred to another tank and used for extracting a fresh charge. The insoluble residue containing calcium sulphide is removed and worked up for the recovery of sulphur.

The solution in the first settling tank (3) is treated with a small quantity of lime and left undisturbed when the remaining calcium sulphide and other suspended particles settle down. The clear liquor is decanted to the second settling tank (4) and treated with chlorine or hydrochloric acid to destroy soluble sulphides. The small quantity of free

sulphur formed is allowed to settle and the clear liquor containing 320-380 gms./litre of barium chloride and 15-20 gms./litre of calcium chloride is either used for salt purification or concentrated in pot (5) for crystallizing out barium chloride.

The concentration pot is made of cast iron with a discharge outlet below and is heated by the flue gases from the furnace. The liquor is rendered alkaline with a small quantity of lime which minimizes corrosion and concentrated to 38°-40° Be' (measured hot), and drained into the crystallizers(6).

The crystallizers are of galvanized iron and are water cooled. On cooling to the room temperature, crystals of barium chloride are formed (about 98 per cent. purity) and separated in a centrifuge (7). The mother liquors are collected in a tank from where they are transferred to the concentration pot. If required, the crude crystals are recrystallized and freed from iron, carbon and other insoluble impurities in a steam-heated pan (8) and a second batch of crystallizers (9).

The pure crystals obtained are separated in a centrifuge (10) and the mother liquor transferred to a sump and used over again for recrystallization.

The crystals are dried at 80° C. in a hot air drier (11) and packed in black sheet drums lined with kraft paper.

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References :

- ¹ Shreve N. and Richard, W. N., *J. Ind. Eng. Chem.*, 1935, **27**, 1488; 1939, **31**, 1173; 1940, **32**, 568.
- ² *Doklady*, 1940, **27**, 972.

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